A transdisciplinary mechanical skills curriculum for Further Education and Training Colleges in South Africa

By

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(M.ED.)

Dissertation submitted in fulfilment of the requirements for the degree

Philosophiae Doctor

in the

FACULTY OF EDUCATION

SCHOOL OF MATHEMATICS, NATURAL SCIENCES AND TECHNOLOGY EDUCATION

at the

UNIVERSITY OF THE FREE STATE

BLOEMFONTEIN

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June 2012

DECLARATION

I hereby declare that this dissertation is the result of my own independent investigation. All the sources consulted and the assistance sought has been acknowledged. I further declare that the work is submitted for the first time at this university/faculty towards the Philosophiae Doctor degree and that it has never been submitted to any other university/faculty for the purpose of obtaining a qualification or any other benefit.

A.J. Klinck

1 February 2012

ACKNOWLEDGEMENTS

I would like to acknowledge the assistance of, and express my sincerest appreciation to, the following people who made this study a pleasant, enriching experience.

- Professor G.P. Combrinck, my promoter.
- Professor Flip Louw, who provided valuable professional assistance with empathy.
- Professor Karel Esterhuyse who did the questionnaire data processing and provided valuable information, guidance and moral support.
- Professor Louis Venter presented excellent guidance in academic writing and rhetoric.
- Alta Sharp assisted in the psychological aspects of the study and gave valuable specific guidance.
- Nanette Lötter for her support, valuable professional feedback and guidance in linguistics and dissertation writing.
- Principals of FET colleges who granted permission to do research at the colleges.
- Faculty heads, senior personnel, personnel and learners at FET colleges who participated in completing college questionnaires, interviews and administering the learner questionnaires.
- Ronet Vrey assisted in acquiring numerous scientific articles on various topics throughout the study.
- Estie Pretorius assisted in acquiring literature from other campuses and universities.
- Rothea Pelser for acquiring numerous sources via interlibrary loans.
- The friendly personnel of the library who were always ready to assist.
- My wife, the "first line of assessment" and valuable technical support.
- My children for their moral support.

The content of this dissertation represents only a fraction of the experiences encountered. Presented the opportunity, I would do it again.

God is merciful.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABET	Adult Basic Education and Training
AC	Abstract Conceptualisation
AD	Anno Domini - After the birth of Christ
AET	Adult Education and Training
ATC	Advanced Technical Certificate
BC	Before Christ
CBMT	Competency Based Modular Training
CE	Concrete Experience
CESO	Centrum Voor Europese Studies en Opleidingen
COTT	Central Organisation of Technical Training
DOE	Department of Education
ELT	Experiential Learning Theory
EMIS	Education Management Information Systems
ETC	Elementary Technical Certificate

FET	Further Education and Training
GET	General Education and Training
HSRC	Human Sciences Research Council
IQ	Intelligence Quotient
LAC	Level Assessment Criteria
LSI	Learning Style Inventory
LSQ	Honey and Mumford
LTM	Long-Term Memory
MERSETA	Manufacturing, Engineering and Related Services Sector Education and Training Authority
N2/3/4	National Certificate 2/3/4
NATED	National Education
NC(OR)	National Certificate Orientation
NC(V)	National Certificate Vocational
NEET	Not in Education, Employment or Training
NOR	Nasionale Opleidingsraad
NQF	National Qualifications Framework
NTB	National Training Board
NTC	National Technical Certificate
OBE	Outcomes Based Education
OHS	Occupational Health and Safety
PIRLS	Progress in International Reading Literacy Study
PMG	Parliamentary Monitoring Group
RAM	Random-Access Memory
RO	Reflective Observation
RPL	Recognition of Prior Learning
RSA	Republic of South Africa
SACMEQ	Southern and Eastern African Consortium for Monitoring Education Quality
SETA	Sector Education and Training Authority
STM	Short-Term Memory
TIMMS	Trends in International Mathematics and Science Study
UNESCO	United Nations Educational, Scientific and Cultural Organization
USL	Unsuccessful Grades 9 to 12 Learners
VAK	Visual, Auditory and Kinaesthetic
VARK	Visual, Auditory, Read/Write and Kinaesthetic

ABSTRACT

South Africa has a low school completion rate of 40% (2002 – 2009), resulting from low-quality education as prime concern (Van der Berg et al, 2011:1, 13). Consequently, this situation signifies a majority of learners being unsuccessful in mainstream education leaving them very little opportunities in "further" education. They (unsuccessful school leavers) have poor further education and employment prospects.

Some of the unsuccessful school leavers resort to FET colleges for further education, but the programmes are not designed to address their specific educational needs. FET (mainstream) schools also refer poorly performing learners to FET colleges, oblivious of the high standard of vocational education programmes and associated entry requirements. Despite the fact that mathematics and physical science are compulsory for engineering studies (NC(V) and NATED), schools refer learners performing poorly in these subjects to engineering studies to "learn to work with their hands." However, these programmes are not specifically designed for skills training per se.

The educational options unsuccessful school leavers have, do not make provision for their educational situation. They cannot learn effectively and this results in poor performance in mainstream school education and vocational education at FET colleges. Their ability to learn is further hampered by poor language, mathematics and science proficiencies fundamental to learning. South Africa does not have an educational component like the second chance schools in Great Britain and Europe to accommodate these learners.

The European Commission initiated second chance schools for out-of-school unemployed (NEET) young people in 1995 and ran 12 pilot projects in 11 countries in Europe and England, from 1997 to 1999 (Chistolini, 2008:219). Greece, *inter alia*, established 48 second-chance schools across the country and reduced school dropout from 22,4% in 1995 to 15,9% in 2006. The situation of unsuccessful school leavers in South Africa, constituting an annual dropout of 60%, necessitates similar education to provide learners opportunities in further education and to give them hope.

South Africa needs to improve learners' ability to learn and develop cognitive and psychomotor ability on a much larger scale than that of European second chance education. Simultaneously, school dropout must also be reduced by improving education on all levels of the system. Both of the mentioned aspects should be attempted by changing educational approach and presentation strategies based on sound psychological learning theories.

Unsuccessful school leavers' education (the South African version of second chance education) should focus more on development of learning ability than the European counterpart does. Learners need to

develop capacity and shed their aversion to learning. Knowledge, fundamental to learning should be acquired.

Unsuccessful school leavers' education requires an approach that initiates education with activities encouraging participation. Cognitive and psychomotor development, founded in these activities, will be more significant and meaningful to learners than subject-focused information (learning content).

The attributes, educational foundation and predisposition of the learners should be taken into consideration in designing education for unsuccessful school leavers. What they bring to the learning opportunities is of paramount importance. Their previous experiences in education will have a major impact on how they will react and reflect on future exposure to educational activities. Replicating their previous experiences is a recipe for further failure. Their education should be based on experiences demonstrating to them their own importance in the processes of achieving the competences required. Strategies containing more encouraging activities that can lure learners into active involvement are indispensible. Classroom sessions, similar to those of their previous experiences of education, should be avoided.

The unpropitious educational situation of unsuccessful school leavers can be addressed by providing education that can accommodate their specific educational needs. A curriculum based on transdisciplinary-integrated education with practicum-based presentation strategies will allow versatility that can accommodate differentiated development and qualifications. Transdisciplinary-integrated education, based on practicum_methodology is inherently structured for skills development across the spectrum of a mechanical skills curriculum. Flexibility is further enhanced by constructivist fundamental learning theory denoting personal knowledge construction from personal perceptions and experiences.

KEY WORDS: learning, constructivism, transdisciplinary, practicum, knowledge integration, differentiated development

OPSOMMING

Suid-Afrika het 'n baie lae skoolvoltooiingsyfer van 40% hoofsaaklik as gevolg van swak kwaliteit onderwys (Van der Berg, Burger, Burger, De Vos, Du Rand, Gustafsson, Moses, Shepherd, Taylor, Van Broekhuizen and Von Fintel, 2011:1, 13). Uiteraard dui die situasie op 'n meerderheid leerders wat onsuksesvol is in hoofstroom onderwys met min geleenthede om verder onderwys te ontvang. Hulle vooruitsigte op verdere onderwys en werksgeleenthede is dus skraal.

Sommige onsuksesvolle skoolverlaters wend hulle tot VOO kolleges vir verdere onderwys, maar die programme is nie ontwerp om hulle leerhindernisse te ondervang en aan hulle spesifieke onderwysbehoeftes te voldoen nie. VOO (hoofstroom) skole verwys swak presteerders na VOO kolleges onbewus van die hoë standaard van beroepsonderwys en gepaardgaande toelatingsvereistes. Ten spyte daarvan dat wiskunde en fisiese wetenskap verpligtend is vir ingenieursonderwys (NC(V) en NASOP), verwys skole leerders wat in hierdie vakke swak presteer, na ingenieurstudies "om te leer om met hulle hande te werk." Hierdie programme is egter nie spesifiek ontwerp vir vaardigheidsontwikkeling as sodanig nie.

Die onderwys opsies wat tot die beskikking van onsuksesvolle skoolverlaters is, maak nie voorsiening vir hulle besondere onderwyssituasie nie. Hulle kan nie effektief leer nie, gevolglik presteer hulle swak in hoofstroom skoolonderwys en VOO kollege beroepsonderwys. Hulle vermoë om te leer word verder benadeel deur 'n gebrek aan wiskunde-, wetenskap- en taalvaardighede, grondliggend aan leervermoë. Suid-Afrika het nie 'n onderwyskomponent, soortgelyk aan die "tweede-geleentheid skole" in Groot Brittanje en Europa, om hierdie leerders te akkommodeer nie.

Die Europese Kommissie (European Commission) het in 1995 tweede-geleentheid skole geïnisieer en 12 loodsprojekte in 11 Europese lande van 1997 tot 1999 van stapel gestuur (Chistolini, 2008:219). Griekeland, onder andere, het 48 tweede-geleentheid skole reg oor die land gestig en terselfdertyd hulle skooluitvalsyfer van 22,4% in 1995 tot 15,9% in 2006 verminder. Die onsuksesvolle skoolverlaters se situasie in Suid-Afrika, met 'n uitvalsyfer van 60%, noodsaak soortgelyke onderwys om leerders 'n geleentheid in verdere onderwys, en dus hoop, te gee.

Suid-Afrika moet op 'n baie groter skaal die leervermoë van leerders verbeter, kognitiewe en psigomotoriese vermoë ontwikkel as in die Europese tweede-geleentheid skole. Terselfdertyd moet skooluitval, met verbeterde onderwys op alle vlakke van die skoolstelsel, verminder word. Daar behoort gepoog te word om beide aspekte, hierbo vermeld, te verwesenlik deur die onderwysbenadering en aanbiedingstrategieë, gegrond op psigologiese leerteorieë, te wysig.

In onderwys vir onsuksesvolle skoolverlaters (die Suid-Afrikaanse weergawe van tweede-geleentheid skole) moet daar meer gefokus word op leervermoë as in die Europese weergawe. Leerders moet

leervermoë ontwikkel en hulle renons in leeraktiwiteite afskud. Kennis, grondliggend aan leervermoë, moet verwerf word.

Onderwys vir onsuksesvolle skoolverlaters vereis 'n ander onderrigbenadering met aanvangsaktiwiteite wat deelname aanmoedig. Kognitiewe en psigomotoriese ontwikkeling wat op sulke aktiwiteite gegrond is, sal meer beduidend en sinvol vir die leerders wees as vakgerigte inligting (leerinhoud).

Onderwys vir onsuksesvolle skoolverlaters behoort ontwerp te word met die hoedanighede en ingesteldheid van die leerders in oorweging. Wat hulle tot die leergeleentheid toevoeg, is van kardinale belang. Hulle vorige ervaring in onderwys sal 'n groot uitwerking hê op hulle reaksie op en weergawe van toekomstige blootstelling aan onderwys aktiwiteite. Navolging van hulle vorige ervarings is gedoem tot mislukking. Hulle onderwys moet gegrond word op ondervinding waarin hulle bewus sal word van hulle eie waarde in die prosesse om bevoegdheid te bereik. Strategieë wat aansporende aktiwiteite insluit en leerders tot deelname inspireer, is onontbeerlik. Klaskamer sessies, soortgelyk aan hulle vorige ervarings van onderwys, behoort vermy te word.

Die ongunstige onderwyssituasie waarin onsuksesvolle skoolverlaters hulle bevind, kan aangepak word met onderwys wat hulle besondere onderwysbehoeftes kan bevredig. 'n Kurrikulum wat op transdissiplinêr geïntegreerde onderwys gegrond is, met praktikum-gegronde aanbiedings, bied veelsydigheid wat gedifferensieerde ontwikkeling en kwalifikasies moontlik maak. Transdissiplinêr geïntegreerde onderwys, gegrond op praktikum-metodologie is inherent gestruktureer vir vaardigheidsontwikkeling oor die spektrum van 'n meganiese vaardigheidskurrikulum. Aanpasbaarheid word verder bevorder deur die konstruktivistiese grondteorie wat persoonlike kennisbou uit eie persepsies en ervarings behels.

KERNWOORDE: leer, konstruktivisme, transdissiplinêr, praktikum, kennis-integrasie, gedifferensieerde ontwikkeling

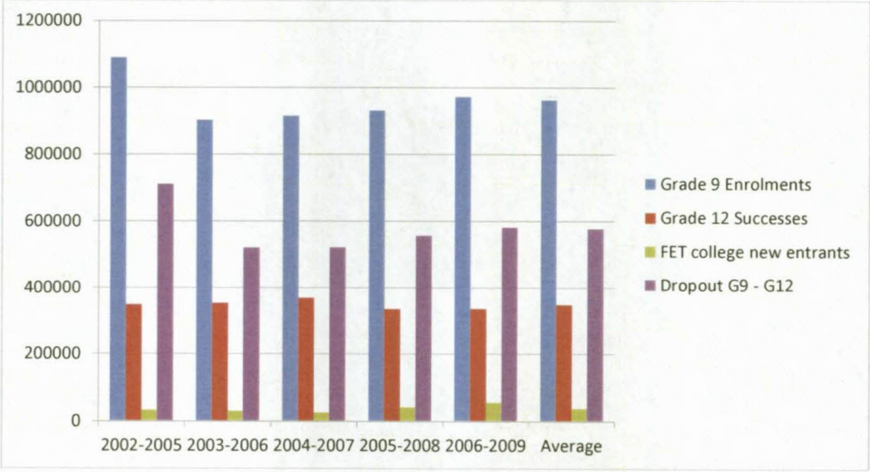
CHAPTER 1

ORIENTATION

1.1 INTRODUCTION

Statistics released over the period 2002 to 2009 (see Graph 1.1) reveal that an annual average figure of 577 722 (60%) learners leaving high school in South Africa (RSA) did so without obtaining a matric certificate (Department of Basic Education, 2010; Parliamentary Monitoring Group, 2010). Further confirmation of the magnitude of the situation is given by Kruger (2008:2), reporting that 60% of the learners were "pushed" out of the school system before reaching matric. Hoffman (2008) even reports a 77% school dropout from Grade 1 to Grade 12. Van der Berg, Burger, Burger, De Vos, Du Rand, Gustafsson, Moses, Shepherd, Taylor, Van Broekhuizen and Von Fintel, (2011:4) confirm the dropout rate of 60% by referring to 40% completion rate. It is a cause for concern when more than 50% of a country's learners fail to achieve their matric certificates. More detail of the South African school dropout rate can be seen in Graph 1.1.

Graph 1.1: School dropout Grade 9 to Grade 12 (FET college "new" entrants deducted) (Department of Basic Education, 2010; Parliamentary Monitoring Group, 2010)

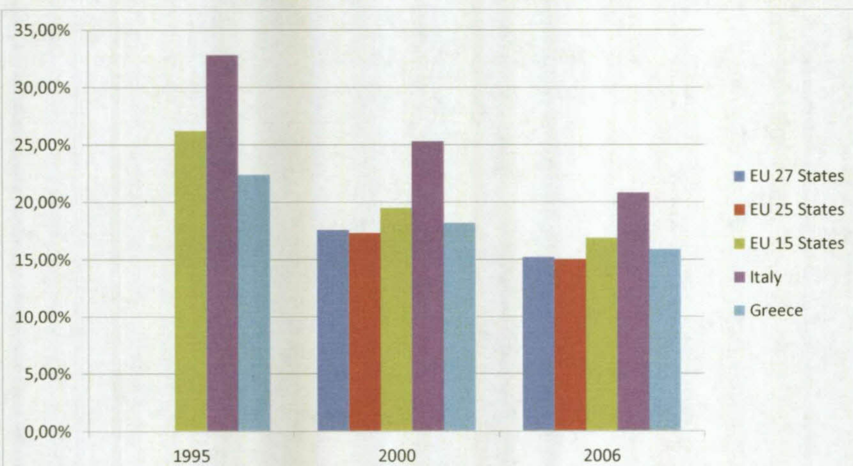


Calculated from information of the Department of Higher Education and Training (2009:17).

In Graph 1.1, Grade 9 enrolment to Grade 12 examination successes were taken as the relevant period because the effect of examination failures on dropout becomes significant in this period. This effect is explained by Van der Berg et al (2011:13) as "assessment in most schools [is] far too lenient and unreliable... and leading to lenient and largely random grade progression" in the local school examinations compared to the national, exit level, examinations. It can therefore be concluded that learners are promoted without demonstrating the competences required for their specific grades leaving them poorly prepared for higher grades.

These phenomena consequently result in South African dropout figures that do not compare favourably with the European statistics provided by Chistolini (2008) (Graph 1.2). Unfortunately, Chistolini (2008) does not specify the names of the different European State groups, but for the sake of comparison, these figures are relevant. School dropout and efforts to counter the problem are more significant in Italy and Greece than in other European states, but the fundamental causes are comparable. The higher dropout rate relates more to the South African Situation. The 2006 statistics of these European states indicate school dropout rates below the United Nations Educational, Scientific and Cultural Organization's (UNESCO) international norm of 21% (Hoffman, 2008). Further comparison with "developed" countries replicates the foregoing statistics.

Graph 1.2: Percentage of persons aged 18 – 24, leaving school prematurely in Europe



(Chistolini, 2008:222).

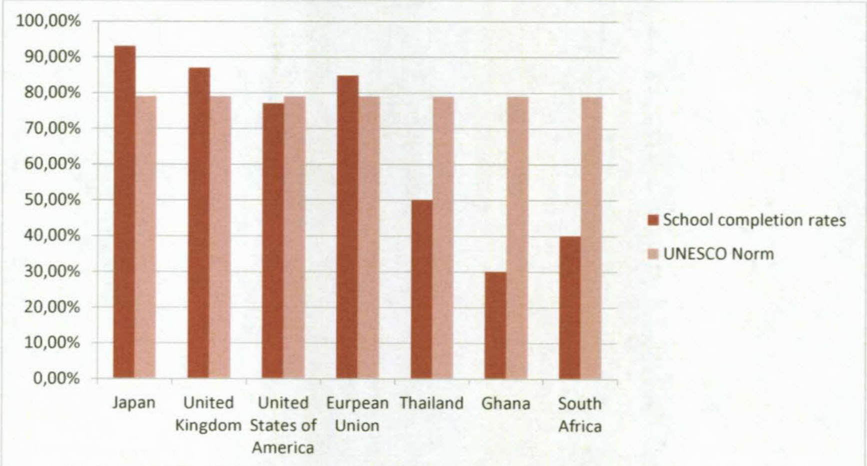
A further noteworthy observation from Graph 1.2 is the reduction in the school dropout achieved by European countries with education improvement measures to deal with the problem (school dropout). This demonstrates the success achieved by addressing the quality of school education as a part of the solution to the problem of school dropout.

Van der Berg et al (2011:4) refer to the dropout rates of other "developed" countries, Japan, the United Kingdom and the United States of America, who all have dropout rates below 30%.

Comparing South Africa's dropout rates with the countries mentioned may seem inequitable, but they are international competition in production and trade. Converting the dropout rates to school completion rates, reveals the "ineffectiveness" of South African education.

The South African school completion rate does not compare favourably with the countries shown in Graph 1.3. This has detrimental consequences for South Africa's competitiveness in the international arena. It also has dire socioeconomic consequences for the country. Gower (2009) calls it a social time bomb. Comparison of this figure with FET college enrolment figures reveals a Not in Education Employment or Training (NEET) situation exceeding the magnitude of the unsuccessful school leavers' situation. South Africa is a role player in the international arena. It is therefore imperative for the country to become and stay competitive in the international economy. Competitiveness can be achieved and sustained through effective education, which is not currently reflected in the official statistics, reports and literature.

Graph 1.3: Comparison of school completion rates of a number of countries



Department of Basic Education, 2010 (EMIS, 2009); Van der Berg et al (2011:4).

The country's acquaintance and competition with the international community are furthermore reiterated by the following statement in the preamble to Act 98 of 1998: "Provide optimal opportunities for learning, creation of knowledge and development of intermediate to high level skills in keeping with international standards." Comparing South Africa's school dropout with Sub-Saharan Africa (SSA) will enhance the picture by providing the necessary balance, but school dropout statistics for the period Grades 9 to Grade 12 from these countries are not readily available.

School dropout in Ghana reported by Sabates, Akyeampong, Westbrook and Hunt, (2010:14) for 2006-07 was 70%. This dropout figure, covering the whole school career, compares favourably with South African statistics, considering Hoffman's (2008) figure of 77%. Wright (2008:1), however, reports a bleak picture of SSA education: "These countries have the highest primary school repetition and dropout rates worldwide and participation at secondary level remains low at less than 20%." Considering the primary school completion rate of SSA of 63% (Ghana 79%), provided by the UNESCO Institute of Statistics (2008) and Sabates et al (2010:10), it is explicable that these countries concentrate on basic education, school grade repetition, overage, gender equity and other primary education concerns.

In SSA education, where the emphasis is on school enrolment, primary school completion, overage reduction and gender equity, it is difficult to obtain school dropout statistic equivalent to those already mentioned because the concern is not focussed on Grade 12 completion or equivalent qualifications (Huggins and Randell, 2007:1). Second chance education is therefore not a consideration. The South African situation is different: statistics are available, school enrolment was 88% for the period 2005 to 2009 and primary school completion 77% (UNICEF, 2010). However, school dropout is a reality with educational, employment and socioeconomic consequences.

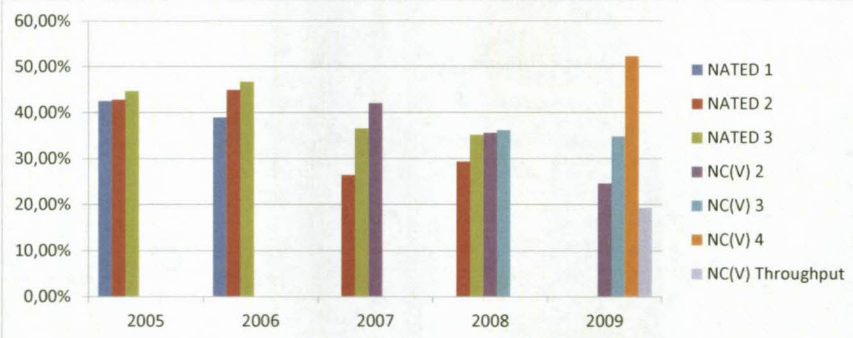
1.1.1 EDUCATIONAL ROUTE RESORTED TO BY UNSUCCESSFUL SCHOOL-LEAVERS

Some of the unsuccessful learners in South Africa will enter further education at FET colleges as a last resort as suggested by the Department of Education, (2007b:5) (RSA, 2008:19). They do not qualify for higher education and have to compete with better-qualified and often experienced people. Facing poor prospects, they resort to vocational education at FET colleges.

The option of vocational education at FET colleges, resorted to by these learners, is not very promising. In the public further education and training sector in South Africa, examination results from further education and training (FET) colleges, Graph 1.4, reveal limited successes.

The National Education (NATED) curricula (often referred to as N-courses) are being replaced with the National Certificate (Vocational) NC(V) curricula. The NATED curricula are the academic components of apprenticeship training and the NC(V) curricula (referred to as programmes) are designed to replace the NATED curricula and with three subjects added are supposed to be the equivalent of Grades 9 to 12 school curricula.

Graph 1.4: National examination subject results of NATED and NC(V), 2005 – 2009



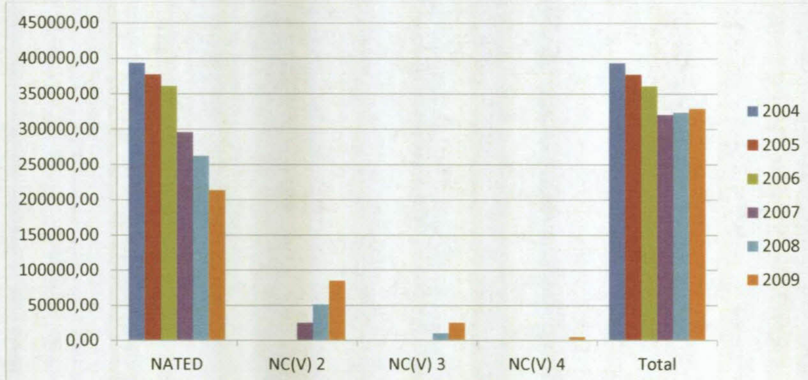
Department of Education (Department of Education, FET College Examinations: Results, 2006 - 2009; Department of Higher Education and Training, 2009:57-64).

In Graph 1.4, the subject successes in the National Education (NATED/N) courses do not reflect the real success or throughput of learners. Judged against the 42% subject successes of NC(V) 2 in 2007 and 23% full course achievements, these NATED subject successes do not reflect the real situation. The NC(V) 2 results are clear indication that subject successes are higher than courses successes. Course successes of 9,63% for NC(V) 2 and 3,13% for NC(V) 3 in 2009 are grim evidence of the situation in engineering studies at FET colleges (Department of Higher Education and Training, 2009:57 - 64). The NC(V) 4 subject results contrast against the other, but adding the throughput to the equations reveals the grim reality of NC(V) engineering education. Nationally, only 1 596 learners ended up in NC(V) 4 mathematics and 114 in physical science. The number of NC(V) 4 certificates issued could not be obtained because Umalusi issues these certificates and the information was not contained in the 2009 report (Department of Higher Education and Training, 2009:26).

The number of learners at FET colleges in Graph 1.5 correlates with the 400 000 mentioned by the Department of Education (2007b:5). A figure of 48% unemployed young people who failed matric and the 42,5% unemployed youth not studying, emphasise the urgency of supplementary ("second chance") education (FET Round Table, 2010:23; Van der Berg et al, 2011:9). A relatively small number (29%) of unsuccessful school leavers attempts further education at FET colleges adding alarming numbers to the NEET population (Smith, 2011:14).

Graph 1.5 gives an indication of the learner population at FET colleges of which an estimated 41% are engineering studies learners (Department of Education, 2004:20). It also reveals the poor progression rate of learners in NC(V) engineering programmes rendering appropriateness for unsuccessful school leavers questionable. Over a three-year period the number of learners reduces drastically from NC(V) 2 to NC(V) 3 and virtually diminished in NC(V) 4 as indicated in Graph 1.5, columns 2, 3, and 4.

Graph 1.5: FET College Enrolments, 2004 – 2009



Department of Education, (2009); Parliamentary Monitoring Group, (2009).

Such limited success is no encouragement for parents and learners to consider NC(V) as an alternative school career in the further education and training (FET) band. Poor educational successes are in contrast with the underlying principle of education and international competition in production and trade. Education is expected to yield reasonable successes in terms of competences and qualifications acquired.

1.1.2 AUTHORITARIAN RESPONSIBILITY TOWARDS (FURTHER) EDUCATION

Effective education is essential in every country in the world and a compelling need in developing and under-developed countries. Development and progress rely heavily on the quality of the workforce in terms of skills, dedication, reliability and values (Department of Higher Education and Training, 2010:6). Acquiring these qualities is the responsibility of each individual and the authorities who should provide the facilities and opportunities for optimum development and life-long learning. Subjected to the standards and influences of the global post-modern society, the outcome of education must meet the demands set by international competition (MERSETA, 2002:2).

Government promulgated laws in 1996 (SA Schools Act), 1997 (Higher Education Act), 1998 (FET and Skills Development Acts) and 2000 (Adult Basic Education and Training Act) for a new dispensation in education. The promulgation of the Further Education and Training Act, Act 98 of 1998 and the Skills Development Act, Act 97 of 1998 has aroused expectations in the vocational education sector of a change for the better – a better dispensation was anticipated (Department of Education, 2007b:7).

Until the amalgamation of the departments of Further Education and Training College Sector and Higher Education, the Further Education and Training Act regulated further education and training in the Further Education and Training Colleges' Sector. The Skills Development Act regulates education and training offered by the Sector Education and Training Authorities (SETA's) from the perspective of labour. South African Sector Education and Training Authorities (SETA's) are the institutions responsible for vocational education and training in the places of work under the authority of the Department of Labour. Learnerships are the education and training programmes administered by the SETA's complemented by in-service training (MERSETA, 2009). These Acts ushered in a new dispensation in education and training.

With the reform of education, the authorities expect to achieve, inter alia, the following as expressed in the Preamble to the Further Education and Training Act 98 (RSA, 1998):

- "Pursue excellence; promote the full realisation of the potential of every student and member of staff, tolerance of ideas and appreciation of diversity."
- "Provide optimal opportunities for learning, the creation of knowledge and the development of intermediate to high level skills in keeping with international standards of academic and technical quality."
- "Respond to the needs of the communities they serve" (RSA, 1998:2).

The success of the amended educational dispensation should be judged against these criteria and the degree to which the needs of South African communities are met. This study is not an evaluation of the "new" educational system. However, the poor success rate and related throughput encouraged investigation into "second chance" education for the unsuccessful school leavers. Improving their socioeconomic situation with a reasonable chance of success with "second chance" education or some other means, should be seriously considered.

1.2 BACKGROUND/RATIONALE

The unsuccessful school leavers have to find employment or improve their skills and qualifications to improve their prospect of earning a living. High unemployment figures in South Africa, rising from 23,6% in the second quarter of 2009 to 25,3% in the second quarter of 2010 and employers who prefer experienced, well-trained employees, predict bleak employment prospects for the unemployed and under-qualified (Statistics South Africa, 2010). Accentuating the situation further is a comment in the 2010/11 Budget Speech of the Minister of Finance: "Furthermore, our bargaining arrangements push up entry-level wages, pricing out inexperienced work seekers" (South African Government Information, 2010).

Cloete, Branson, Zuze, Papier, Needham and Nel (2009:11) emphasise the dilemma in South African education by commenting, "Providing ten years of education to youth who do not complete their final two years of schooling is an enormous waste of educational resources, and leaves this group extremely vulnerable to unemployment." This comment also applies to learners who enrolled but failed to complete matric, i.e. unsuccessful school leavers in general.

South Africa finds itself in the situation of having 51% of its youth unemployed with unfavourable educational prospects for its specific needs (South African Institute of Race Relations, 2011). These learners need means, mode and manner to escape their socioeconomic circumstances.

1.2.1 EDUCATION, AN ESCAPE ROUTE OUT OF A POVERTY TRAP

Van der Berg et al (2011:8) emphasise the importance of quality education and successful completion of Grade 12 for "stable and lucrative employment." For some of the unsuccessful school leavers Grade 12 may remain out of reach, but appropriate education can bring other opportunities within reach. Improvement of the socioeconomic situation of unemployed youth depends on improving qualifications and/or skills (Van der Berg et al, 2011:3, 9). "Towards solving this problem, it is essential that South Africa develop highly skilled and socially committed professionals who can strengthen the country's enterprises, services and infrastructure and contribute to the production, acquisition and application of knowledge, however statistics show large numbers of youth are not accessing educational opportunity" (Smith, 2011:2). Smith, (2011:11) refers to the "close relationship between poverty and levels of education" and Van der Berg et al (2011:3) reiterate the importance of education in the efforts to alleviate poverty. By improving skills and qualifications, learners create more and better prospects for themselves and increase socioeconomic development possibilities.

1.3 STATEMENT OF THE PROBLEM

Further education at FET colleges does not seem to succeed in the proposition of improving education qualifications of a significant number of unsuccessful school leavers. Hopes of improving qualifications are foiled by poor NC(V) engineering programme results and poor throughput revealed by the statistics in Graph 1.5. These poor results prove these programmes ineffective in preparing learners in significant numbers for higher education and occupations. NC(V) programmes fail to meet higher education enrolment criteria contrary to the claim of the Department of Education (2007b:11, 13). They also reflect negatively on the vocational prospects of unsuccessful school leavers attainable with FET colleges' NC(V) engineering education.

The Department of Education, however, focuses on "... offer(ing) programmes that prepare students for employment, higher education and entrepreneurship" and their target population includes "unemployed young people with Grades 11, 10 and 9 (unsuccessful school leavers)" (RSA, 2008:31). Judged on the official statistics, revealing poor educational success, these learners do not have the educational foundation to proceed or return to FET college education (Graph 1.4). "Access programmes" and "bridging" courses, as suggested by Smith (2011:30), could give learners a better opportunities to progress and succeed in the FET colleges' vocational programmes.

Cloete et al's (2009:12) comments, referring to "This group clearly requires multi 'second chance' school opportunities, ..." point towards an educational solution to the problem. Supporting the notion, Van der Berg et al (2011) and Smith (2011) focus on the improvement of the broader educational situation including second chance education and bridging. They emphasise improvement of the socioeconomic situation with higher levels of education, which seems to evade unsuccessful school leavers.

In summary of the situation, it can be reiterated that unsuccessful school leavers face a reality of bleak prospects in their educational and employment situation. Statistics reveal poor success in FET college programmes (Graph 1.4). FET colleges do not offer orientation and/or bridging courses on the scale required to accommodate them (Department of Education, 2007b:13). Learnerships and apprenticeships require relative small numbers of new entrants annually compared to the number of potential candidates and number of unsuccessful school leavers (MERSETA, 2009). In learnerships and apprenticeships attainment, unsuccessful school leavers face fierce competition from better-qualified people. A similar situation is prevalent in employment and it can be concluded that their situation results from poor qualifications and inadequate skills. It is therefore imperative that the skills and qualifications of unsuccessful school leavers be improved to empower them to alleviate their socioeconomic wretchedness.

Consequently, the overarching research question must be asked: ***What will constitute a curriculum that will afford unsuccessful school leavers an opportunity to construct an educational foundation upon which they can build further capacity?*** This translates into ways and means, which can be established to afford significant numbers of these learners knowledge and skills that will enable them to improve their prospects.

Encompassing the envisaged aspects of improving the educational situation and socioeconomic prospects of unsuccessful school leavers, the research question needs to be differentiated into a number of subsidiary questions. The following subsidiary questions distinguish aspects of the process to be followed:

- What is the international and South African situation with respect to vocational education for unsuccessful school leavers?
- Which curriculum development and design theories can form a basis of a curriculum for unsuccessful school leavers?
- Which learning theories, principles and approaches can form a basis for a vocational curriculum for unsuccessful school leavers?
- What are stakeholders' (senior personnel) and unsuccessful school leavers' perspectives on an appropriate educational approach to be followed in an envisaged vocational curriculum for unsuccessful school leavers?
- What would be an appropriate structure and format of a vocational curriculum for unsuccessful school leavers?

Creating a second chance for unsuccessful school leavers in education to acquire knowledge skills and values – build a significant educational foundation – could give these learners hope of further education, development and improved prospects. Designing a suitable curriculum could encourage further research and further development of alternative education for unsuccessful school leavers in the educational system of South Africa. "Some key suggestions are to use FET colleges as 'second chance' institutions for preparing students in alternative access programmes as well as bridging courses" (Smith, 2011:30).

1.4 GOAL, AIM AND OBJECTIVES OF THE STUDY

As introduction, a brief comment on the features of goals, aims and objectives serves as orientation. The goal, in this context, is the situation or condition that the endeavour intends to achieve. The aim, on the other hand, is the intention of the study and directs the activity of the endeavour towards the goal. While the aim is the more concrete, measurable "means" to realise the broader notion, the goal is the desired state of affairs or aspiration of the study – the vision. Objectives are considered the stepping-stones in pursuit of the aim (Bezuidenhout, 2005:15). Ritz (2006) regards goals as "broad statements of what should be accomplished" - "be long range and are somewhat removed." Aims are described as "statements [to] provide shape and direction to the more specific actions designed to achieve some product or behaviour."

For the sake of this study, these explanations will be accepted. The goal of the study is the somewhat removed aspiration of "second chance" education for unsuccessful school leavers and the aim is an appropriate curriculum, focussing on one subfield in education as initial part of the all-encompassing endeavour.

1.4.1 GOAL

The goal of the study is the provision of alternative "second chance" education for unsuccessful school leavers that can improve their ability to re-enter further education and enhance socioeconomic prospects. Taking their previous poor educational performances in mainstream schooling and NC(V) programmes into account, the education should accommodate their needs and provide means to address their inability to learn effectively. However, the goal encompasses education for unsuccessful school leavers over the spectrum of their aptitudes and interests for specific occupations rendering it a comprehensive endeavour, which will involve at least a team of experts to accomplish. In pursuing the goal this study could achieve only the status of example or guideline for the other envisaged curricula, which would constitute the "second chance" education for unsuccessful school leavers.

Although the goal, being the broader context of alternative education for unsuccessful school leavers over the whole spectrum – in the sources called "second chance education" – is beyond the means and authority of this study, the aim and objectives are pursued with all the available resources and courage that could be mustered. This study focuses on one facet of the mentioned education. Further research in other educational fields to cover the spectrum of aptitudes and interests of unsuccessful school leavers should be encouraged. This study, together with the suggested research can focus the attention on the plight of these learners and the need for alternative education to address it. Encouraging such research will be an attempt at translating the envisaged education into reality.

Cloete et al (2009:61) comment, "Apart from the negative social impact of such a large group of young people, the skills needs of South Africa's developing economy clearly demand a creative solution to this undesirable social phenomenon." This signifies the establishment of a comprehensive effort to address the plight of the not in education, employment or training (NEET) youngsters, which include unsuccessful school leavers comprising a significant portion of these people. "Expanding a range of educational and training opportunities," and changing policy, is proposed by Cloete et al (2009:16).

In Cloete et al's (2009:16) discussion of "[P]otential responses to challenges facing South Africa," he proposes three "principles of widening access" to education, which include "programme differentiation." "Differentiation – 'one size fits all' policies will not work; there has to be policy, funding, function and programme differentiation." Within this "programme differentiation," unsuccessful school leavers education could find a niche. While Cloete et al (2009) emphasise higher and further education collaboration and covering the broader spectrum, this study focuses on a specific field of education for unsuccessful school leavers.

1.4.2 AIM

Acknowledging the role of education in the envisaged solution to the phenomenon, the aim of this study is to design a curriculum for unsuccessful school leavers according to the conclusion of this study. Such a curriculum should facilitate education to equip them with knowledge, skills, values and an aptitude for opportunity. Transdisciplinary-integrated education, based on practicum methodology is inherently structured for skills development across the spectrum of a mechanical skills curriculum – cognitive and psychomotor development. Providing the proficiency needed as foundation and capacity for further education and development, such a curriculum could afford these learners a wider spectrum of opportunities.

As part of the curriculation process, establishment of an educational foundation, matching the different abilities, frames of knowledge, experiences and addressing the learning insufficiency of unsuccessful school leavers, will be pursued. Carl (2010:66) emphasises the importance of the educational level of the learners as a "point of departure" in curriculation. Underlying the educational foundation is a fundamental learning theory that should be established to brace the processes involved in curriculation and concomitant education. These processes will be guided by a set of objectives derived from the research questions.

1.4.3 OBJECTIVES

Pursuing the aim, the objectives are "milestones" along the curriculum-design route. Planning a route begins with the point of orientation – where you are when starting the journey Carl (2010:66). It is therefore imperative to be acquainted with the current situation as orientation towards the processes aimed at accomplishment of the "destination." These processes will be guided by the following objectives involving different facets of the study:

- To give an overview of the international and South African situation with respect to vocational education for unsuccessful school leavers.
- To establish the applicable curriculum development and design principles for a vocational curriculum for unsuccessful school leavers.
- To determine the typical attributes of unsuccessful school leavers.
- To identify applicable learning theories and approaches that will foster the design of a vocational curriculum for unsuccessful school leavers.

- To determine perspectives of stakeholders (senior personnel) in the field of vocational education on the attributes of unsuccessful school leavers.
- To design a curriculum for unsuccessful school leavers according to applicable curriculum development principles, learning theories and empirical data gathered from stakeholders.
- To have the designed curriculum for unsuccessful school leavers evaluated by peers (Delphi evaluation method), and adapt the designed curriculum according to the recommendations received.
- To propose a curriculum for unsuccessful school leavers.

These objectives incorporated in the study, are directly related to the research questions, which include the learners, institutions and curriculum. They constitute the core factors in the deliberation and design of the envisaged curriculum. Manifestation of the goal is regarded a more comprehensive endeavour beyond the reach of a single study – a somewhat remote aspiration of "second chance" education for unsuccessful school leavers across-the-board.

1.5 RESEARCH DESIGN AND METHODOLOGY

A literature study and an empirical investigation are the two main components of the research aiming at designing a curriculum for unsuccessful school leavers. The nature of the information required – hard (quantitative) evidence, occurrences, experience, opinions – necessitates a mixed method approach. Creswell and Garret, (2008:326) commented that "collection, analysis and interpretation of both quantitative and qualitative data in a study focussing on the research methods", is the propensity of applied methodologists. These authors' concern that "the division between what constitutes quantitative and qualitative data" may not always be clear, is a consideration in the research. However, combined methods will constitute the research.

By following up the quantitative enquiry with a qualitative one, according to Casebeer and Verhoef, (1997:5) a richer, deeper understanding of the area of investigation can be attained. Creswell (2008:552) adds significance to mixed method research by stating that understanding of the research problem and questions is improved. The constructive nature of the study, having the intention to design a curriculum for the unsuccessful school leavers, classifies it as applied research (Lategan, Hay, Holtzhausen, Truscott and Vermeulen, 2003:34). Constituting the process of research foundation construction and capacity building, the literature review of the study involves different aspects as indicated in the objectives.

1.5.1 LITERATURE STUDY

A literature account is acknowledgement of relevant existing scholarship and evaluation thereof, together with critical discussions, generalisations, associations, deductions and conclusions. Discussions and deductions are done in conjunction with elaboration on the specific theme/subject matter in an attempt to improve coherence (Wolfe, 2006:11 of 14). The account should be an interrelated and compelling discourse culminating in a final conclusion and outcome. Discussion encompasses clarification of the notions, concepts and theories revealing relationship with existing bodies of knowledge, confirming consistency with current theories, offering new insights and proposing new theories or mechanisms (Wolfe, 2006:12 of 14).

The literature study is an endeavour to establish a historical context and fundamental theory underlying the envisaged education as integral part of the envisaged curriculum complemented by educational approaches and education strategies. Learner differences and appropriate approaches were included in a process of establishing premises and guidelines.

A dissertation must contribute to existing knowledge. Replication of other authors' work does not add value or contribute towards scholarship. In discussing the attributes of the literature, a study should demonstrate comprehension and critical reflection on the theories, hypotheses, assumptions and statements (Phillips and Pugh, 2008:56). Phillips and Pugh (2008:48) state that research goes beyond description and requires critical examination and analysis. Research is not about repeating the "right answers" but is a struggle to find out what the right answers may be and then to evaluate their adequacy. Henning, Gravett and Van Rensburg (2005:5) posit that developing an argument in response to the research question from the literature and research data towards an ultimate conclusion, constitutes the basic procedure in dissertation construction.

A literature study is therefore a process of declarative knowledge acquisition and capacity building through procedural knowledge in research and the processes required in the field of study (know-how) (Henning et al, 2005:26, 48, 49). Incorporated in capacity building is the know-how of reporting the results and conclusions (outcomes) of the study. Being an integral part of the research project and major aspect renders the contribution of the literature study in the research design and methodology section, consequential.

Bracing the empirical research with the literature study can provide confidence in the credibility of the results. The selection of literature is based on the presumed solution to the plight of the unsuccessful school leavers in engineering studies. Shuttleworth (2009:1 of 2) valued "[a] literature review [is] a critical and in depth evaluation of previous research". Against this criterion, the search for significant information in selected literature was conducted.

1.5.1.1 Literature selection

A literature study can constitute a complete research project on its own or an initial phase of declarative knowledge construction for empirical research (Neuman, 2000:445; Mouton, 2001:86). It is acknowledged that the framework of this study is constructed upon literature incorporating a component of empirical research for authentication of the educational situation of unsuccessful school leavers. Neuman (2000:445) lists four goals of a literature study:

- "To demonstrate a familiarity with a body of knowledge and establish credibility."
- "To show the path of prior research and how a current project is linked to it."
- "To integrate and summarize what is known in an area."
- "To learn from others and stimulate new ideas."

These goals apply to independent literature review projects as well as the first phase of mixed-method research projects. All four goals are pursued in an effort to establish historical background and context, fundamental theory, educational approach, educational strategy and curriculum structure. The literature study, according to the preparation plan, comprises the relevant objectives in 1.4.3.

A curriculum design in vocational context, encompassing a historical context, an education approach, fundamental education theory, education strategies and a design and construction procedure, dictated the selection of literature. Covering these themes in the exploration of the literature revealed significant content for the knowledge foundation of the study. Account of this literature study is incorporated in the relevant facets of the curriculum design process. Added to the literature is a second facet representing the more concrete evidence of the educational situation of unsuccessful school leavers: official statistics.

1.5.2 OFFICIAL STATISTICS

This second facet of the literature study is the statistical evidence guiding the empirical research, revealing specific hard evidence of the situation of unsuccessful school leavers. These official statistics involve the records of the Department of Education and Department of Higher Education and Training. Further substantial data is obtained from reports and comments of other institutions, e.g. the Parliamentary Monitoring Group and South African Media. A major contributor in disclosing the educational situation of unsuccessful learners in engineering studies at FET colleges is the empirical research comprising a survey and interviews.

Confirmation of the existence and magnitude of the presumed situation of unsuccessful school leavers preceded a literature study to determine viability and credibility of the envisaged study and the nature of the research conducted. Statistics of the Department of Education, EMIS and available reports on examination results and relevant educational matters provided the required statistics and commentary (reflections) (Graph 1.1 and Graph 1.4).

Statistics, provided by the Department of Basic Education (2010), Parliamentary Monitoring Group (2009/2010), Department of Education (2009), media reports (Kruger, 2008:2), Department of Education FET College Examinations (2009) and Department of Higher Education publications (2009), evoked, support and supplement the empirical data. The statistics provide perspective, confirmation of the situation, a basis for further investigation and serve as criteria for judgement of questionnaire and interview findings.

Well familiarised with the unsuccessful school leavers problem, the empirical research data contributed to the specifics required to address the denotation of the research questions: a curriculum and concomitant education. These specifics include elaborating on the situation analysis: *inter alia,* the educational profile of unsuccessful school leavers, suitable education and the entrepreneurial situation. Accomplishment of perspective on the educational situation of unsuccessful school leavers necessitates an empirical research.

1.5.3 EMPIRICAL RESEARCH

Although the literature study constitutes the major component of the research, further elaboration on the educational situation of unsuccessful learners requires more in loco information to establish conversance with and perspective on the situation. Establishing conversance and perspective requires information relevant to the situation in consideration, implying further investigation. The investigation was done by means of an empirical research comprising a combined quantitative and qualitative method.

1.5.3.1 Confines for this study

The confines for this research are a manageable cohort of unsuccessful school leavers with a manageable range in the field of study resulting in the selection of a specific group of learners in a specific educational field at FET colleges. Directed by this rationale, purposeful sampling was conducted.

Narrowing down the number of unsuccessful school leavers to those who have demonstrated some desire to improve their skills and qualifications, led to the selection of FET college enrolments. Focussing the study on a specific curriculum necessitates selection of a specific field within the broader context of FET college programme offerings. Amongst the assortment of FET college programme offerings the field of engineering was chosen because it can cover a spectrum of related basic knowledge and skills required as educational foundation for vocations in the engineering field.

1.5.3.2 Sampling

Purposeful sampling, in view of the notion of Creswell (2008:214), in the selection of participants and sites for the research was done in anticipation of information richness and relevance to the situation of unsuccessful school leavers (cf. 5.2.3.2). Features of this primarily qualitative method of sampling, suits the combined method sampling of this study in terms of sample identity and definable characteristics (Creswell, 2008:152). Du Plooy (2005:100) posits that the parameters of the sample (and sites) should "share several common characteristics", which would be represented by educational features the unsuccessful learners share and the programmes offered at the faculties of education institutions selected.

In stratum selection in the South African society, all 50 FET colleges were invited to participate in the research, but the samples comprise only personnel at the engineering faculties because they match the selected education field of the study (Creswell, 2008:154). The engineering faculties were targeted because they are regarded as some of the "last resorts" for unsuccessful school leavers by the Department of Education (2007b:5; RSA, 2008:19). According to Creswell (2008:154) selecting a specific stratum in a population based on specific characteristics ensures inclusion of the desired features for the research. It can be further focussed on the characteristics by selecting a specific sample matching the requirements.

Engineering faculties at FET colleges were selected because they share common characteristics in programmes offered and the learners they enrol. In FET colleges, with 14 different official programmes, a specific programme group can focus the study in terms of educational approaches, fundamental theory and educational strategies. Representativeness within the population stratum of FET college personnel was achieved by involving FET colleges across the country in the research (cf. 5.2.2.2; 5.2.3.2).

Within the college structure, the engineering faculties were selected to reduce the range of the study to one specific educational field. From the colleges' personnel establishments, heads and senior lecturers of engineering faculties at each college were included in the sample of respondents. Faculty heads and senior lecturers are lower level management staff with direct involvement, experience and perspective on the situation of the learners concerned. Heads of faculty also have access to the databases of the FET colleges. These members of the engineering faculties at colleges were requested voluntarily participation in the research by granting interviews or completing the questionnaires.

1.5.3.3 Quantitative method

In this mixed method research, the quantitative component is a questionnaire survey comprising numeric, Likert scale and scale items to collect quantitative data. Questionnaires and questionnaire guides for personnel were sent to the engineering faculties of all 50 FET colleges in South Africa accompanied by letters requesting permission to do research at the colleges, introduce the exercise and motivate participation. Quantitative data were collected with the questionnaires. The data were processed to attain frequencies that assisted in the situation analysis and consequently the curriculum design. To complement the questionnaires, interviews were conducted with senior staff of engineering faculties at FET colleges.

1.5.3.4 Qualitative method

The qualitative component is open-ended interviews conducted with faculty heads, senior and experienced lecturers at engineering faculties of FET colleges who were prepared to do so. These interviews constituted the qualitative facet of the research. Open discussions provided comprehensive relevant information and the opportunity for discovery of additional unexpected information – information not anticipated (Best and Kahn, 2003:323). Probing questions were used to initiate and stimulate conversation and ensure responses to anticipated matters and concerns. Validity and reliability were accomplished in the mixed method research with triangulation.

Interviews with faculty heads and senior personnel at the engineering faculties of FET colleges constituted the qualitative facet of the research. The interviews were tape recorded, transcribed and sorted into concepts and notions in an effort to establish themes and patterns. Opinions, views and experiences were interpreted and evaluated for incorporation in the framework of analysed data.

1.5.3.5 Triangulation

Adding triangulation to the measures taken, the study achieved the reliability and validity required. Triangulation is, according to Du Plooy (2005:39) inter alia, the combination of two or more data collection methods in an attempt to establish validity and reliability of research. In this research, triangulation was established by combining quantitative and qualitative research methods, correlating and comparing results and benchmarking it against official statistics and literature information.

Interview and personnel questionnaire responses complemented by statistics facilitated triangulation, proving validity and reliability (Neuman, 2000:124, 125). Looking at the phenomena, concepts, perceptions, opinions and arguments from different angles and different people's perspectives not only improves value but also enhances researcher perspective. The data obtained from interviews and questionnaires were analysed, interpreted and evaluated. Confirmation or contradiction and judgement of information were accomplished by interpreting and comparing the processed data. Interpretations were enhanced or contradicted, where valid, by involving the official statistics and literature as references and norms, e.g. research responses on mathematics proficiency vs. examination results.

Triangulation – comparison of quantitative data, qualitative data and official statistics where appropriate – was used to ensure validity and reliability. Data were weighed and compared to determine confirmation or contradiction for the establishment of a database for the curriculum design process.

Validity and reliability of the research paved the way for credibility of a curriculum, designed with the data as guidelines. The information from the literature study, statistics, questionnaire responses and interviews culminated in the design of a suitable and credible curriculum for unsuccessful school leavers.

1.6 DEMARCATION OF THE FIELD OF STUDY

Finding a solution to the problem of school dropout is a more comprehensive enterprise than can be managed with this study. This study is therefore limited to an educational solution for unsuccessful school leavers with a propensity for, and an interest in the engineering field. Focusing on a curriculum for these learners, the scenario in which the learners find themselves, educational approaches, fundamentals of education and educational strategies, are the key features of the study. Educational approaches and strategies are concerned with the functional aspect of the curriculum: how effective learning can be brought about.

Apprenticeships and learnerships are excluded because they are the responsibility of the SETA's. The intention with the envisaged curriculum is to enable learners to build an educational foundation upon which they can proceed with capacity building.

1.7 CLARIFICATION OF CONCEPTS AND TERMINOLOGY

Short explanations are given for a few key terms and concepts used in this study. These explanations are not intended to formulate definitions. It is rather an attempt to elucidate the concepts and terms in the context of the study and enhance understanding of the arguments involved.

Unsuccessful school leavers are learners who leave school during the period Grade 9 enrolment to matric examination without obtaining a Grade 12 qualification (school-end certificate).

School dropout is a term used for an educational situation where learners terminate their school careers before obtaining a matric (school-end) certificate. The term has a negative connotation that may offend people. Referring to ***unsuccessful school leavers*** is preferred to school dropouts.

Further education and training colleges are the 50 mergers of 152 technical colleges, some colleges of education and training centres. In 2002, these institutions were grouped and transformed into a smaller number of establishments in terms of Act 98 of 1998 (RSA, 1998: 15). FET colleges offer post school formal and nonformal education and training to learners in the NQF 2 to NQF 4 and higher education in the NQF 5 band. Post NQF 4 education at FET colleges is phasing out from 2009 to 2012 (Strumpf, Papier, Needham and Nel, 2009:66).

Formal education at FET colleges focuses on delivery of vocational education designed, prescribed and instituted by the Department of Higher Education and Training. These curricula are vocationally based programmes preparing learners for occupations in trade, industry and the public sector. Formal education is the joint responsibility of the parents, authorities, learners and possible participation of employers in learnerships, apprenticeships and partnerships.

Nonformal education is the second focus of FET colleges. It is offered to people with a desire to improve knowledge and skills in specific fields over a wide spectrum including hobbies and personal interests. These short courses are offered at colleges on demand of the local population.

Informal education starts at home as the responsibility of the parents or guardians. Responsibility gradually shifts from the parents to the learners until full responsibility resides with the latter at maturity/independence. Responsibilities of the partners in education are diverse and differentiated into different aspects of the educational process.

Other terminology and concepts are clarified when they occur in the script. It is the intention to obey semantics without attenuating meaning of concepts and terminology in their relevant contexts.

1.8 ARRANGEMENT OF THE STUDY REPORT

This text is an account of the research, inferences and consequential outcome of the study. Different aspects – concepts, theories, approaches, practices – contribute in establishing a foundation for the procedures progressing towards accomplishment of the aim. Arranging the different aspects in this specific format is an attempt to establish a coherent presentation of the processes culminating in the ultimate outcome.

Chapter 1 is an overview of the initiation, motivation, approach and intention of the study - orientation.

Chapter 2 is an account of a international and South African overview of vocational education models in an attempt to establish suitable education for unsuccessful school leavers.

Chapter 3 is the establishment of curriculum development and design theories for a transdisciplinary vocational curriculum for unsuccessful school leavers.

Chapter 4 reports on learning theories, learning principles and approaches for a transdisciplinary vocational curriculum for unsuccessful school leavers.

Chapter 5 is an account of the empirical research on the design of a transdisciplinary vocational curriculum for unsuccessful school leavers and the proposal thereof.

Chapter 6 concludes the envisaged curriculum design and concomitant education for unsuccessful school leavers, the study and proposes some recommendations and research.

1.9 CONCLUSION

School dropout, currently available programmes, the prospects they engender and the limited demand for new entrants into the labour market in this specific field and level of engineering, form the milieu in which the study is done. Judged on the throughput of schools, sixty percent of learners enrolling in Grade 9 do not respond well to mainstream school education. In vocational education at FET colleges, the situation is no different. Their poor results in FET college programmes are in succession of poor school achievements. Bleak employment prospects are aggravated by equally bleak educational opportunities. Addressing the problem of school dropout will require intervention on two fronts: providing appropriate second-chance education to the unsuccessful school leavers and improving school throughput.

Identifying the problem – the plight of the unsuccessful school leavers – and anticipating a solution leads to deliberation on the methods and means to accomplish the aim within the educational scenario. Restricting the focus of the study to the design of a curriculum for these learners, directs the study towards the educational structure, educational programmes, learners and institutions involved in relevant education. Within these boundaries, the empirical research was conducted. All the outcomes of the processes should culminate in the aim of the study: a curriculum for unsuccessful school leavers.

Chapter 2 is an account of the historical context of unsuccessful school leaver's education comprising relevant vocational education history, consideration of existing relevant education in South Africa and second chance education for school dropouts in foreign countries. Nonformal education is also considered for possible contributions to the comprehensive educational endeavour required to alleviate the educational needs of unsuccessful school leavers. An overview of South African and international education regarding education for unsuccessful school leavers provides the context of the study.

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CHAPTER 2

A GLOBAL AND SOUTH AFRICAN OVERVIEW OF VOCATIONAL EDUCATION MODELS IN CONTEXT

2.1 INTRODUCTION

Establishing the international and South African situations with respect to vocational education for unsuccessful school leavers can provide the context for the envisaged curriculum. In Chapter 1 the magnitude of school dropout was revealed and education identified as a significant aspect in addressing the situation. Educational intervention of this kind is usually established within a context of vocational education considering second chance education in foreign countries and the history of upliftment of people. Deeply rooted in human existence, according to Monroe (1956:1 – 7) and Pistorius (1972:25), vocational education has a long history with significance to human societies.

Vocational education history provides an educational background for the envisaged curriculum for unsuccessful school leavers' aimed at capacity building. Establishing the historical, international and South African context of vocational education for unsuccessful school leavers gives an overview of the international and South African situation with respect to vocational education for unsuccessful school leavers.

2.2 HISTORICAL CONTEXT

Purposes of vocational education changed over time as circumstances changed. Two distinct purposes can be identified: providing skilled manpower for trade and industry, and socioeconomic upliftment (Peel, 2008:1 of 3). The latter resurfaced in 1995 with the initiation of second chance schools is Europe and the United Kingdom (Chistolini, 2008:219). In South Africa the educational and socioeconomic situations necessitate urgent consideration of educating people to improve their socioeconomic circumstances regardless of trade and industrial demand (Liebenberg, 1942:21 as reported by Van Rensburg, 1946:4; Behr and Macmillan, 1971:203).

The historical context of vocational education and more specifically technical education, provide perspective on the proposal for second chance education in South Africa for educating young people to improve their educational and socioeconomic prospects (Swanson and Holton, 2009:35; cf. 1.2.1). Since ancient times, manual labour and associated education (training) were not regarded activities for upper class people, but in the unsuccessful school leavers' situation snobbery is inappropriate (O'Connor and Robertson, 1999:1 – 3).

2.2.1 HISTORICAL CONTEXT OF VOCATIONAL EDUCATION

The development of the envisaged curriculum is done in the context of technical education within the broader framework of vocational education. Within the framework of vocational education, technical education has a long history stretching over millennia. Technical education was utilised for practical hands-on training in the arts and crafts (artisan training), social upliftment of underprivileged or delinquent youngsters and skills acquisition for personal development and hobbies.

A brief history of technical (vocational) education gives perspective, elucidates and adds some "flavour" to the "Cinderella" of education – education for "the dull in all brainwork" (HSRC/NTB, 1985:2; Bilton, 1996:1). Technical education, throughout the history of education, has been relegated to a status of inferiority to academic education, often because of the methods utilised and the slow progress made. Nevertheless, it gave substance to technological development and technology provided the means for social development.

Some of the features and legacies of ancient and not so ancient forms of education have prevailed to this day, e.g. education shapes the individual to the benefit and security of the state; the Greeks regard manual labour as demeaning; "handicraft is largely for pupils who were *dull in all 'brain work'*" (Monroe, 1956:47; Bilton, 1996:1 of 2; Swanson and Holton, 2009:35). These features, often negative, still influence the image and application of education associated with manual skills. Deeply rooted, these features can only be countered by substantial effective education in the aspect often referred to as "training." In referring to manual activities of learners, however, "training" does not suffice in the effort to encapsulate the concept of perceptual-motor development – hands-on education.

The history of skills (practical) training, and its position within the educational milieu over the ages of human development, places it in context and provides perspective. Understanding the need for education together with the trends and facets of education enhances the interpretation of educational scenarios. Since ancient times skills training in an educational setting has been overshadowed by academic education for the upper classes of society (Coetzee, 1970:53, 54). However insignificantly documented, technical education has played an important role in the progress of civilisations (Peel, 2008:1 of 3). Creating skilled manpower, enhancing industrial productivity, developing new technology and improving the quality of life, render technical education a significant component of an educational system. Vocational and in smaller context, technical education does feature in ancient education, although poorly documented (Hasaki, 2007:1 of 3).

2.2.1.1 Ancient vocational/technical education

The ancient Greek civilisation was not the only one who deprecated manual labour and associated education. Regarding training in the arts and trades as the domain of less intelligent or lower social class people do not diminish the importance of these skills to civilisation. The following summaries are evidence of the existence and scope of these arts and trades:

- In ancient Israel trades such as pottery, sculpting, carpentry, farming, stockbreeding, shoe making, smithery, tool making and commerce were included in the curriculum. (Pistorius, 1972:75). Boys who did not attend "higher" education were educated in agriculture, stockbreeding or the trades of their fathers (Coetzee, 1970:32).

  The description of the building of the Temple of Solomon, 1 Kings 6 and King Solomon's palace, 1 Kings 7, in the Bible give a fair perspective on the craftsmanship and quality of the workmanship of the time – 961 to 941 BC (Ayayo, 2005:489 – 494). The sheer scale of the objects handled is astonishing and reveals relatively advanced civil engineering capacity.

- Even though vocational and technical education were not part of Chinese education before 1870 – or not well documented – some significant inventions in the world originated in ancient China. The invention of gunpowder, papermaking, the compass and printing technology were four of the greatest, though certainly not all. The Chinese built a seismoscope in 200 AD, discovered gunpowder around 850 AD and were responsible for many more inventions (Wu, 1991:2 of 7).

- In ancient Greece trades and crafts such as pottery, sculpting, carpentry, farming, cattle raising, shoe making, smithery, tool making and commerce were amongst the apprenticeships of ancient Greece. Master craftsmen and merchants schooled the boys in the crafts (trades) and businesses for a period of six years starting at the age of 12 (Peel, 2008:1 of 3).

  The great technological accomplishments of the ancient Greeks are evidence of the developmental value these accomplishments had for artisans and lower class people, as substantiated by Swanson and Holton (2009:35): "Yet, training in manual arts was not completely shunned by the Greeks, for it was through an enduring system of apprenticeship among the lower classes that skills were developed in construction, manufacturing, agriculture and other areas that were instrumental in the accomplishments of Greek civilisation." Apprenticeships of ancient Greece reveal signs of the mediaeval guilds that followed later. They were very often family-based, transferring the technical and artistic knowledge from father to son or relative (Hasaki, 2007:1 of 3).

- The legacy of Roman education to Western civilisation lies in excellence in organisation and administration. Their contribution was not so much expansion of and inventions in the sciences but the practical application of theoretical knowledge. Greek knowledge and inventions were applied in their civil engineering structures, devices and agricultural development (Coetzee, 1970:63).

  The Romans did more for vocational education than the Chinese and the Greeks did, but there is no evidence of special attention to less intelligent learners besides degrading to lower social status and more practical training (Monroe, 1956:176; Coetzee, 1970:67). The destruction of the Western Roman Empire caused a collapse in social discipline and left a void in education.

- In the middle ages, after the destruction of the Western Roman Empire and the abdication/disposal of the last emperor, Romulus Augustus on 4 September 476, the Roman Catholic Church was the primary authority left with the enormous task of conservation of civilisation (Monroe, 1956:236).

The activities, aimed at self-support in monasteries, provide some evidence of attention to training in arts and crafts. The monasteries were closed communities where monks had to provide themselves with all the necessities for their daily needs. They did small scale gardening and had their own mills, bakeries and shops to sustain their communities. Inevitably, the fact that they did their own construction and maintenance meant that they had to have some building competence and knowledge of mechanical skills. Developing these skills corresponded with their perception of the virtues inherent in manual labour (Swanson and Holton, 2009:37).

The legacy of ancient civilisations regarding the status of craftsmanship and concomitant education is not of prime concern, but the vocational and technical education, as a division thereof, developing the skilled labour to sustain and advance technology and socioeconomic upliftment of unsuccessful school leavers.

2.2.1.2 Ancient to medieval vocational education and apprenticeships

Trade skills and knowledge have been passed on to new generations, from father to son or within family or group relation since prehistoric times. Initial imitation developed into a kind of a "sit-by-Nellie" teaching and training like the in-service training of apprentices. In that sense, vocational education is as old as mankind, but institutional (organised) vocational education developed into *apprenticeships* in the ancient civilisations and further with the establishment of the mediaeval guilds and the appearance of railway transport and mining industries (Gallinelli, 1979:19; Ralls, 2008:1 of 2).

Apprenticeship is an educational arrangement for the schooling of candidates in the procedures, methods, techniques and theory of relevant crafts or trades. Since the establishment of apprenticeships they had two distinct facets: practical experience in the workplace and applicable knowledge or theory that later came to be referred to as the academic component.

The Egyptians had apprenticeships for scribes as early as 2000 B.C. This ancient vocational education started with reading and writing, followed by practical (in-service) training under an experienced scribe. This very early vocational education had the knowledge (theory = reading and writing) taught in a "classroom" situation, followed by in-service training (the actual application of the knowledge) by a tutor. Even today, apprenticeships continue to rely on this type of training in the actual work situation. According to Finch and Crunkilton (1979:2), "The apprenticeship form of instruction thus remained virtually unchanged until the nineteenth century."

The term "apprentice" actually means to learn. It is derived from Middle English and the French word "aprentis", in turn derived from the old French word "apprendre", which means to learn, derived from the Latin word "apprehendere" – to apprehend (HSRC/NTB, 1985:14; Butterfield, Summers, Holmes, Daintith, Isaacs, Law and Martin, 2003:79). The connotation later changed to *teaching and training* in the trades, arts and crafts.

2.2.1.3 Origin of vocational education in South Africa

The history of vocational education reveals that churches, and government at a later stage, resorted to skills training for uplifting of impoverished, neglected and delinquent young people because hands-on competence has direct market value (Behr and Macmillan, 1971:203). This kind of educational intervention took place in the past and can be done again (Behr, 1988: 138). However, South African authorities have an educational obligation towards the learners who do not respond well to the (mainstream) educational programmes available to them – FET school and FET college education.

South African craftsmanship/artisanship and handcrafts (hands-on occupations) did not escape the ancient social legacy of disparagement by society. However, craftsmanship and associated education (training) were indispensable in social upliftment and technological development in the country (Behr, 1988: 138). Vocational (and technical) education in South Africa originated in social upliftment of groups of people, followed later by industrial development. Currently, the poor success rate of mainstream education engenders a similar situation leaving the majority of the learners poorly educated and unskilled.

The Moravian Missionary Society and churches established education focussing on socioeconomic upliftment from as early as 1815 (Behr, 1988:138). As early as 1815, the Khoikhoi people had mastered the trades of knife making, carpentry and blacksmithing at the missionary station, Genadendal. Following on these humble beginnings, the Moravian Missionary Society established industrial training for Coloureds in the Cape Colony in 1855 and Blacks in Natal in 1864, in an effort to improve the situation of the Coloureds and Blacks in the two settlements.

The Natal Government Railways (1884), Salt River facility of the South African Railways (1890), Cape Town School Board, Central South African Railways (1902 Pretoria/1904 Bloemfontein), Cape Town Chamber of Commerce (1905), Department of Prisons (1911) and private individuals in Bloemfontein (1906) also established vocational education and part-time education, which were amalgamated with technical education into technical colleges and institutions (1929, Bloemfontein) (Behr and Macmillan, 1971:204; Schoeman, 1987:179; Muller, 2001:12 – 14). Nonformal education continued from the initial establishment of evening classes to meet the demand of local populations until inclusion in the technical colleges' programmes.

In the unsuccessful school leavers' situation, society can once again resort to vocational education to provide the development for socioeconomic upliftment of a group of young people not complying with the norms of mainstream education. In an effort to establish appropriate attributes and guidelines for the envisaged education, basic aspects of education are investigated including psychological learning theories, educational approaches and strategies to accommodate learner differences. Establishing further guidelines is done with an overview of OBE, vocational education and second chance education in foreign countries.

2.3 OBE AND VOCATIONAL EDUCATION

Outcomes-based education (OBE) is corollary to competency-based education (Van der Horst and McDonald, 1997:7). Killen (2010:54) confirms that, "William Spady (1994; 1998) is not the only person to have made significant contributions to the theoretical foundations of outcomes-based education." Focusing on the outcomes (end-results), what learners can do with what they have learned, i.e. the competences acquired, appears to complement vocational education.

2.3.1 OUTCOMES-BASED EDUCATION IN SOUTH AFRICA

After introduction of outcomes-based education in South Africa in 1998, it was revised a few times in a short period of time. The initial Curriculum 2005, based on the version of Spady's (1994) philosophy of OBE, followed by the Revised National Curriculum Statement (RNCS) 2002 and the National Curriculum Statement (NCS) 2005 (RSA, 2002; Department of Education 2005; Lombard and Grosser, 2008:562).

2.3.1.1 South African version of OBE

South African outcomes-based education is, according to Spady (2008), not "real" outcomes-based education. It lacks a "clear, well defined or compelling framework of (critical) outcomes upon which the educational system could legitimately and consistently be based" (Spady, 2008a). This fundamental flaw, obscuring real educational intent, does not allow consistent professional construction of educational guidelines.

The South African version of OBE failed the qualification of real OBE in more criteria and strategies (Spady, 2008):

- The four "power" principles did not feature significantly.
- Poor and incomplete implementation strategy.
- Important role players, e.g. school principals and high profile educationists were excluded from the processes.
- Lack of profound retraining of educators (teachers) to bring about a real paradigm shift.
- Under-estimation of the deeply rooted educational traditions in South African education that Spady (2008a) calls "institutional inertia."
- Educational traditions were upheld while trying to implement OBE.
- Outcomes as demonstrations of learning requiring competence never got engraved in the South African educational system – never exceeded the boundaries of content reproductions and handling.
- Outcomes were vaguely described – did (do) not fully and comprehensively describe the intended educational development (Van der Horst and McDonald, 1997:16).
- The South African version never reached the level of "employing a future-focused, outside-the-box, life-role approach to outcomes, curriculum, instruction and the contexts where learning and performance should take place" (Spady 2008a). This feature does not reflect adequately in the critical and developmental outcomes.
- "Nightmare of paperwork for South African educators – teaching, assessing and marking every micro task and assignment in the syllabus as if they were actual *outcomes of*

significance" (Spady 2008a).

Over-emphasising the end-result (competence) led to negligence of procedures, methods and techniques – application of knowledge and integration of declarative and procedural knowledge. Neglecting the power principles contributed to the fundamental flaw in South African OBE (Spady, 2008). The four "power" principles describe a clear continuous focus, monitoring, guidance and assessment (all continuous) of the processes towards the outcome(s) with the educator in a facilitating capacity just out of the "spotlight."

These processes (experiences) involve integrated acquisition of knowledge, skills and values – declarative and procedural knowledge – in developing proficiency. Ignoring the psychological processes reduces learning opportunities to imitations of educator performances disregarding cognitive and affective development despite the emphasis in the critical outcomes. How the outcome is accomplished, and the assessment thereof, is as important as the end-result because it constitutes cognitive, perceptual-motor and affective development (Froese, 1994; Spady, 2008).

In South Africa, OBE failed to engender the expected critical thinking skills presumed in the critical outcomes: *Identify and solve problems and make decisions using critical and creative thinking* (Lombard and Grosser, 2008:561, 571). This is part of the negligence of cognitive development, the over-emphasis of "doing" and the facilitation role of educators.

Scrutinising the explanations (definitions) of "outcome" clearly reveal continuity in the OBE educational processes envisaged: "culminating demonstration of learning," "demonstration of procedures" – "describe, explain, design, construct, produce, negotiate and operate," "doing requires skills and competence." These attributes, cognitive, perceptual-motor and affective development, should feature in the formulations of outcomes (Denver, 1995; Spady and Schlebusch, 1999:30, 38, 39; Spady, 2008). The fact that they did not is reiterated by Pretorius (2008) in her comment that teachers did not know what to teach or how to teach and stopped teaching reading and writing. This fact is confirmed by the empirical research (cf. 5.3.3.2). Unsuccessful school leavers lack the fundamentals for learning: language, mathematics and science proficiency – too little attention was given to cognitive development in the subjects fundamental to further education and development.

The focus was so intensely on the outcomes (end results) that teaching did not take its proper place. Teachers stepped out of the "spotlight" and out of the educational processes into an over-emphasised facilitator role. South African education moved away from factual knowledge in favour of the "previously neglected" feelings, beliefs and social attributes.

Factual and ready knowledge and cognitive development was not of prime importance to the educational authorities, but developing the affective aspects was (Spady, 2008).

The revised National Curriculum Statement and curriculum statements of school and FET college education still endeavour to incorporate "good" features of OBE (Department of Education, 2005; Department of Education, 2006; Department of Education, 2006a). The remnants of Curriculum 2005 are still prevalent in the curriculum statements and subject guides of South African education.

It must be reiterated that there are schools and educators that perform excellently despite the negative features discussed above. It can be assumed that they studied the educational system thoroughly and analysed the outcomes, curriculum and subject statements to establish well-designed education for their learners. Professionalism, dedication and commitment are prime attributes in educational success. Unsuccessful school leavers' "education" should "learn" from South African outcomes-based education, avoiding the pitfalls and incorporating the attributes and qualities of the approach.

2.3.1.2 Critique on Outcomes-Based Education

Outcomes-based education has features significant to education in general (cf. 4.5.1), but as an educational approach on a national scale, it lacks key attributes. Clear definitions for competences and grading are required for further education and career guidance. Learners' inherited potential and aptitude are ignored in the notion "everybody can learn." In this regard, OBE does not make ample provision for differentiation and pays very little attention to the more intelligent learners. Not all learners are capable of the higher order mental processes required for complex critical thinking and problem solving. These features are mentioned but not how differentiation should be handled (Spady, 1994).

The educational (some historical) examples that Spady (2008) mentions as OBE are education for small groups where time and schedule are (were) adaptable and personal relationships and tutor/mentor attention intrinsically embedded in the structures, e.g. craft and trade guilds, apprenticeships, pilot training and sports training. Apprenticeship training is often one-to-one education (Spady, 2008). OBE for larger numbers, based on the same principles and modes of application, is more inclined to engender problems in this regard leading to a demand for more intense control over personnel and the educational processes.

In larger groups, it will be difficult, and often impossible, to allow learners to progress at different rates resulting in learners at various levels in the same classroom in the same timeframes. Schedule pressure has motivational value. Unlimited time and schedule will require special measures to hold learners accountable for time spent (Closson, 1993; Spady, 2008).

Factors that are less prominent in "traditional education" are the influences of tutor proficiency, dedication and employer (educational authorities) commitment to the education of the learners. In apprenticeships, with a one-to-one tutor/apprentice ratio, the quality of the education (training) relies heavily on the proficiency of the tutor and the employer. Good tutors and employers provide good education and training. In conventional FET education, more than one educator is involved in the education of relevant groups.

In South African OBE too little emphasis was placed on distinguishing cognitive, psychomotor and affective learning outcomes – knowledge, skills and values (declarative and procedural knowledge). The distinction could have been made within the structures of the outcomes, which would have led to better-formulated and user-friendly learning outcomes and promotion of knowledge and skills integration. The outcomes could have stipulated the procedures of acquiring procedural knowledge, assessment thereof and the role of declarative knowledge in the proficiency envisaged. "Outcomes are what students actually can do with what they know and understand" (Spady, 1994:49).

2.3.2 PUBLIC FET COLLEGE ENGINEERING PROGRAMMES

Technical colleges in South Africa had their humble beginnings in nonformal education during the nineteenth century – socioeconomic upliftment, skill and qualification improvements (Behr, 1988:138). The initial focus of technical colleges was nonformal education in addition to the provision of a qualified workforce for trade and industry, but the situation has changed to emphasis on apprenticeships and again in 2007 to general vocational education.

2.3.2.1 Current public FET college programmes

Currently, Public FET Colleges offer 14 different programmes on the National Qualifications Framework (NQF) 2 to 4 level (Further Education and Training Level) – five engineering programmes, five commercial, two hospitality, one management and one agriculture programme (SAQA, 2010; Department of Higher Education And Training, 2011). These vocational programmes are designed to prepare learners for specific occupations and higher education (Department of Education, 2007b:11, 14). The Department of Education (RSA, 2008:22) confirms that "Grade 9 learners who have the intellectual maturity to succeed in the NC(V) programmes", are targeted. Learners who successfully completed their General Education and Training (GET) phases were supposed to enrol in NC(V) programmes, but that did not realise (Eastern Cape Province Government, 2004:2; RSA, 2008:22).

The low success rate, revealed by the official statistics (Graph 1.4), is ample proof that NC(V) programmes are not suitable to satisfy the educational needs of unsuccessful school leavers. Replacing the NATED programmes with NC(V) programmes did not satisfy the expectations of learners, personnel and the authorities to such an extent that phasing out the former was postponed until later notice (RSA, 2010; RSA, 2010a).

In FET college education, NC(V) (outcomes-based) programmes were introduced in January 2007 to progressively replace the NATED programmes (traditional). The NATED engineering programmes were designed as academic component of apprenticeship training. A change in learner profile in engineering studies at FET colleges, caused by an influx of unindentured learners (non-apprentices) in significant numbers into engineering studies since 1987 and outdated syllabi necessitated review (Pretorius, Telephone conversation 12 June 2006). Colyn (1985:26) reports that the majority of the learners in engineering studies at technical colleges were apprentices, contrary to the situation since 1987, signifying the change that inevitably also changed the educational focus (function) of FET colleges.

2.3.2.2 NATED engineering programmes at FET colleges

National Technical Education Engineering N1 – N3 was designed as the academic component of apprenticeship education and training (NATED 191). The admission requirement for N1 is Grade 9 or higher. Each level (N1 – N3) comprises 4 subjects, but apprentices can acquire certificates with an applicable trade theory and two other subjects (RSA, 1996:7). The four subjects for the mechanical field are mathematics, engineering science, engineering drawing and a relevant trade theory. Languages are excluded from the N courses (Department of Education, 1988).

National Technical Education Engineering (NATED engineering programmes) has serious limitations. These programmes are too short to meet the SAQA criteria of 120 credits to be registered on the NQF. Three subjects that are required to obtain an N1 to N3 certificate, with approximately 75 contact hours per subject, can result only in 22,5 credits and four subjects only 30 credits. Even if two languages from another FET college faculty are added, it cannot accomplish the time criterion (RSA, 1998a:9).

Unindentured learners can achieve an N-certificate with any three subjects because a trade theory is not compulsory as for apprentices (RSA, 1998a:11). This ruling further downgraded the value of the N certificates as alternative education for unindentured learners. In an effort to improve the skills of young people, some FET colleges offer short skills development courses to accommodate some of the learners.

Regulation 8.1 (RSA, 1998a:8) places NQF 2 to 4 status completely out of reach of the N1 to N3 engineering qualifications. In terms of applied knowledge, basis for further learning, opening-up access to further learning, status and enhancement of employability the NATED engineering courses are under suspicion. They do not comply with the requirements of the critical outcomes because they were developed before 1994. The syllabi are outdated and irrelevant to the trades they were supposed to support and without the practical training they are virtually useless. Learners do not develop the knowledge and skills in these qualifications to acquire the capacity to perform adequately in any reasonable occupation or relevant trade. Omitting the trade theory is jeopardising the qualification further.

There are no substantial relationships between the subjects to establish correlation and work scheme synchronisation to build a significant unitary structure for worthy credible learner development. Dating from an era where not even the trade theory and the practical training were synchronised, the subject structures render the learning content insignificant. Very little of the subjects' content is of real value to apprentices in their effort to become artisans. The lack of motivation to establish relationships between subjects' content and the relevant trades further contributes to diminish the value of the academic components of engineering N-courses (Department of Education, 2007b:9).

The purpose of the NATED engineering courses was to add some form of academic education to apprenticeship training. In its purpose, content, execution and structure it cannot meet the requirements of education for the majority of learners (unsuccessful school leavers) enrolling in engineering studies at FET colleges. Without a trade theory and practical workshop training, these courses are useless to unindentured learners including unsuccessful school leavers. The educational needs of these learners (unsuccessful school leavers) necessitates a different kind of education and NC(V) requires a "different kind" of learner.

The phasing out of the NATED programmes has been postponed until further notice. These courses have been extended to unindentured learners (RSA, 2010; RSA, 2010a). NATED programmes are not a solution to the plight of unsuccessful school leavers. They were designed as an academic component for apprenticeship training and lack the substance to be regarded as valued academic qualifications equivalent to Grades 10 to 12 – what they were assumed to be, practical experience (workshop practice) excluded. Languages are not included in the NATED programmes for engineering. The duration of these courses is another drawback and does not meet SAQA requirements.

With only 75 hours contact time per subject, the learning content is not comparable with school subject content where 200 hours are allocated per subject. Study time for NATED subjects is spread over 10 weeks with no holiday breaks compared to a full year with three holiday breaks of the school calendar. The contact time for NATED courses is further reduced by the enrolment delays at the beginning of each term. These factors reflect in the examination results and competency of learners.

NATED courses were offered to unindentured learners for 20 years (1987–2006) with doubtful success. They did not improve employability significantly because the major component, practical training and often a trade theory, was lacking. With three/four subjects, designed for apprentices, not equivalent to school subjects and often without a trade theory, N qualifications of unindentured learners do not meet the expectations of the people concerned. The poor success rates (Graph 1.4) further disqualifies NATED courses as education for unsuccessful school leavers.

NATED courses do not meet the needs of unsuccessful school leavers. They do not make provision for languages and the other subjects are inferior in scope and depth due to the time constraint. Unsuccessful school leavers need to improve educational capacity in the subjects fundamental to learning in the field of engineering: mathematics, science and languages.

The NATED (N) programmes are even less suitable to meet the educational needs of unsuccessful school leavers than the NC(V) programmes are. According to the Department of Education (2007, 9) these N programmes "have some value, but are generally outdated ... some of which have not been revised since the 1980's." The NATED engineering programmes were designed as academic component of apprenticeship training, making them purpose-specific. A further disqualification, concerning education for unsuccessful school leavers, is the exclusion of languages from the syllabi.

2.3.2.3 NC(V) engineering programmes

FET college engineering programmes are regarded as existing relevant education against the background of the scarcity of further learning opportunities for unsuccessful school leavers pointed out by Cosser (2010). Evaluation of Engineering and Related Design may reveal significant features that can contribute towards establishment of the educational entrance level of NC(V) and the relevance of learning content for the envisaged curriculum.

National Certificate (Vocational) (NC(V)) is an FET college programme assortment consisting of 14 subfields covering a wide range in the spectrum of occupations in South Africa, from education and development to engineering (Department of Education, 2007b:14; Department of Higher Education and Training, 2010; Appendix F). These programmes lead to seven-subject qualifications on the NQF 4 level equivalent to a Grade 12 certificate (Department of

Education, 2006; Department of Education, 2007b:10–13). Two hundred hours per subject contact time, which includes vocational practical application, renders its attributes unrivalled by other NQF 4 qualifications.

Comparison between school and NC(V) subject guides reveal much copying from school National Curriculum Statements, which is further evidence of the equality between school and NC(V) programmes on curriculum level (Department of Education, 2005; Department of Education, 2006a). However, curricula do not constitute education. Implementation effectiveness, as reflected in school Grade 12 and NC(V) examination results, are of paramount importance. Some subjects of NC(V) programmes have higher standards than equivalent school subjects due to the inclusion of specific higher standard components.

NC(V) 4 mathematics, for example, differs from school Grade 12 mathematics by the inclusion of integration and complex numbers in the NC(V) programme study guide. *"Use and understand basic principles of integration in order to be able to calculate volume and area. Use and understand other sets of numbers such as complex numbers to solve non-real equations particularly with reference to electrical problems"* (Department of Education, 2006b:3). Adding these two divisions of advanced mathematics to NC(V) 4 mathematics increases the standard and complexity beyond that of Grade 12 mathematics.

Study guidelines do not provide clear specific guidance to educators regarding learning content, learning material and the "world of work" applications of curriculum content (Department of Education. 2007). However, mathematics guidelines are the exception, but fall short of providing ample guidance regarding practical ("world of work") applications. Too much is left to the discretion of educators. Practical application of construction of formula for the solution of specific problems, again are not specified or explained adequately. Statistical models are mentioned without specifying exactly what and how they should be dealt with. Vagueness of description and too little information make interpretation of the study guides difficult and susceptible to dissimilarity between different interpreters.

NC(V) programmes are welcome improvements on NATED programmes, but the high standard put them out of reach of the majority of the learners, specifically unsuccessful school leavers, enrolling at FET colleges. Allowing learners to choose between NC(V) and NATED programmes does not solve any problem and puts NC(V) in jeopardy. The main objection, is the duration of NC(V) programmes. The second most prominent objection is the calibre of learner FET colleges are compelled to enrol. Appropriateness of NC(V) as unsuccessful school leavers' education is discussed in Chapter 5.3.13.2. In Chapter 1, the statistics given and calibre of learners targeted (RSA, 2008:22, 23), put the situation in perspective:

- 400 000 learners at FET colleges, with an approximated 30 000 – 40 000 new enrolments in engineering studies per annum, but industry needs only 12 500 new entrants in their labour market at this level (artisan) of occupation. Why should approximately 30 000 learners annually enter the engineering NATED programmes, which are specifically developed for apprenticeships? NC(V) affords learners a wider range of educational and career choices. (*Smith (2011:14) states that FET colleges serve only 29% of school dropouts (unsuccessful school leavers) annually, translating into 167 539 learners in all the faculties at FET colleges.*)

- FET colleges do not enrol learners with an aptitude for and an interest in specific occupations in NC(V). The majority of FET college enrolments are unsuccessful school leavers who could not cope with school curricula. The Department of Education envisaged different candidates for NC(V) "... not because they are failures of other parts of the education system" (RSA, 2008:22). "With regard to targeting, colleges are to focus on the following groups:
    - Unemployed Matriculants
    - Unemployed youth with Grades 11, 10 and 9 – (the ability required is not mentioned)
    - Grade 9 learners who have the intellectual maturity to succeed in the NC(V) programmes
    - Adults who (i) are employed but need specific skills related to their job performance (ii) wish to enrol in the NC(V) programmes (iii) wish to enrol for an AET (Adult Education and Training) qualification (iv) wish to do an entrepreneurship development programme" (RSA, 2008:22, 23).

The intention behind the NC(V) programmes was to afford successful Grade 9 learners, with an interest in and a propensity for specific occupations, an opportunity to enrol in the National Certificate Vocational (NC(V)) programmes the following year. That vision is not becoming a reality (Eastern Cape Province Government, 2004:2; RSA, 2008:19). Learners should be recruited in Grade 9 for NC(V) 2, but FET colleges are still burdened by the negative connotation of "technical" education (Bilton, 1996:1; Barnes, 2004:18). Resulting from that, the "academic profile" of the engineering learners at FET colleges remains the same and colleges fail to become "first choice" institutions (Department of Education, 2007b:1). Graph 1.5 confirms the situation by illustrating corresponding numbers and poor examination results (Graph 1.4) of the learners.

The learners that should enrol in NC(V) programmes do not do so for reasons that lie beyond the scope of this study. NC(V) programmes may not be what could be expected, but they are better options than school or NATED education for learners who prefer vocational education and have the ability to succeed at that level of education – apprenticeships and learnerships excluded. Resorting to NC(V) or NATED courses because of inadequate results at school, is not an option; this reiterates the necessity for unsuccessful school leavers' second chance education.

2.3.2.3.1 Qualification value

Qualification value of NC(V) is currently an issue, which is discussed in Chapter 5. NC(V) engineering programmes are not regarded by SETA's as equivalent to artisan's training (apprenticeships and learnerships) due to insufficient workshop (practical, including workplace experience) training (MERSETA, 2009; cf. 5.3.13.1). HE requires higher marks for enrolment by NC(V) candidates than matriculants.

It cannot be expected of unsuccessful school leavers to progress in programmes equivalent to mainstream school programmes in which they could not respond adequately. The poor success rate of learners in the NC(V) programmes and the insufficient practical training disqualify NC(V) programmes as appropriate education for unsuccessful school leavers. Further confirmation of the state of affairs is disclosed in the empirical research results in Chapter 5.3.

2.4 EDUCATIONAL OPTIONS FOR SOUTH AFRICAN LEARNERS

The public education system of South Africa comprises, besides general education and training (GET), FET school education, FET college education, higher education (HE) in the mainstream, learnerships and apprenticeships. Each level (and educational institution) has its enrolment policies and requirements. Learners, who do not respond well in mainstream education, have limited options in public education due to these requirements.

2.4.1 HIGHER EDUCATION

Higher education is out of reach of unsuccessful school leavers because they do not comply with the admission requirements of higher education institutions. Admission requirements of higher education institutions for NC(V) candidates exceed the criteria for matric certificates – with the exception of the Higher Certificate – rendering these learners, without matric certificates, out of contention. According to the Minimum Admission Requirements set by the Higher Education Act, 101 of 1997, (RSA, 2008a:7, 8) minimum requirements for qualifications at Institutions of Higher Education are:

- Higher Certificate: "A National Senior Certificate (NSC) with a minimum of 30% in the language of learning and teaching of the higher institution."

- Diploma: "A National Senior Certificate with a minimum of 30% in the language of learning and teaching of the higher institution, coupled with an achievement rating of 3 (Moderate Achievement, 40% - 49%) or better in four recognised NSC 20-credit subjects."
- Bachelor's Degree: "A National Senior Certificate with a minimum of 30% in the language of learning and teaching of the higher institution, coupled with an achievement rating of 4 (Moderate Achievement, 50% - 59%) or better in four recognised NSC 20-credit designated subjects." (RSA, 2008a:7, 8)

"[A]dmission requirements must as far as possible predict student success in the programmes for which they are enrolled". Institutions of higher education have, furthermore, "the right to set specific admission requirements to particular programmes" (RSA, 2008a:6).

The admission requirement of a National Senior Certificate already disqualifies unsuccessful school leavers from higher education enrolment. Further requirements just disqualify them further from enrolment in higher education courses.

Unsuccessful school leavers will need re-entry into further education to improve their qualifications if higher education is regarded as a proposition. Re-entry into further education would require gradual establishment of a sound educational foundation because the current education programmes fail to do so (Graph 1.1; Graph 1.4). The envisaged bridging programmes for unsuccessful school leavers at FET colleges (cf. 5.3.11) can afford learners the opportunity to establish the educational foundation required for re-entry into further education and training FET (NQF 2 – 4) to accomplish the required standard of higher education admission.

In the educational scene, they can only choose between private institutions and public further education and training (FET) colleges because they do not qualify for higher education. Smith (2011:30) mentions that less than 30% of the unsuccessful school leavers end up at further education and training (FET) colleges. They enrol on the National Qualifications Framework (NQF) 2 level as a "last resort" in further education (Department of Education, 2007b:5; RSA, 2008:19). Poor educational success in these programmes, however, does not offer much hope of qualification improvement or skills acquisition.

2.4.2 LEARNERSHIPS AND APPRENTICESHIPS

The demand for new entrants on the artisan level of the labour market is limited. Trade and industry can absorb only a certain number of artisans annually. Annually, approximately 12 000 learnerships and apprenticeships are awarded (MERSETA, 2009). In the National Artisan Development Plan it is reported that approximately 5 000 artisanship certificates are awarded per annum and a target of 12 500 artisans should be "produced" by industry to reach the target of 50 000 over a four year period, ending 2014 (Department of Labour, 2007; RSA, 2008:39). Artisan status can be accomplished by completing an apprenticeship or learnership in the relevant programme. This option in vocational education, acquisition of learnerships or apprenticeships, has two major obstacles for unsuccessful school leavers, limited "vacancies" and competition with better-qualified candidates.

These numbers are insignificant compared to the numbers of unsuccessful school leavers and learners in engineering studies at FET colleges. An average of 577 722 learners drop out of school annually and new entrants into engineering studies at FET colleges are an estimated 30 000 – 40 000 annually (Graph 1.1; Graph 1.4). Smith's (2011:30) comment that the further education and training college sector "serves less than 30% of the need" virtually represents the number of learners studying at FET colleges. Another obstacle makes acquisition of learnerships and apprenticeships difficult for unsuccessful school leavers.

Unsuccessful school leavers have to compete with better-qualified candidates for learnerships and apprenticeships. Only 20% of the learners who achieved matric exemption enter higher education at public higher education institutions. The other higher education "candidates", together with the 75% who passed matric without matric exemption, is fierce competition for the unsuccessful school leavers (Smith 2011:29).

Unlike South Africa, some countries offer second chance education unsuccessful school leavers can resort to in an attempt to improve skills, qualifications and therefore employability or re-entry into further education. Not in *education, employment or training (NEET) young people in these countries are afforded opportunities to escape their precarious socioeconomic circumstances.*

2.5 COMPARABLE CURRICULA

Information – especially curricula and syllabi – about education equivalent to the envisaged education for unsuccessful school leavers is not readily available. Programmes in South Africa, which can afford unsuccessful school leavers opportunities to improve skills and qualification, are not readily accessible due to financial constraints (private institutions) or do not address the need for education foundation building. Comparison is therefore based on the primary concepts of unsuccessful school leavers' education.

2.5.1 FET COLLEGE NONFORMAL EDUCATION IN THE RSA

The other alternative currently available to unsuccessful school leavers, skills development programmes, is not well promoted or supported by all the FET colleges (Department of Education, 2007b:50-151). These courses are supposed to be self-sustaining, which place (financially) them out of reach for the majority of unsuccessful school leavers. Furthermore, they are primarily units from learnerships, which are not comprehensive enough to serve the purposes identified for unsuccessful school leavers' education. Excluding NC(V) and skills development programmes from the options available to unsuccessful school leavers at Engineering Studies faculties of FET colleges, leaves them with limited alternatives.

Nonformal courses at FET colleges cover a wide variety of disciplines with computer-related programmes being the most popular. Further confirmation of nonformal (normally short) courses is documented in the publication of the Department of Education, (2007b:51 – 151).

Short enrichment courses are developed for people who want to improve on their existing body of knowledge and skills or satisfy specific interests, e.g. hobbies. They do not meet the educational needs of unsuccessful school leavers because these programmes exclude the requirements for comprehensive education programmes – fundamentals, core and elective learning (Department of Education, 2007b:57, 97).

In the skills development programmes, the focus is on specific skills and educational development is neglected. Units from learnerships are popular because learners can accumulate credits towards full learnerships and qualifications in the field of engineering. Fundamental and elective learning are not catered for. Skills development programmes are selections of practical units from SETA qualifications – merely fractions from the core learning of learnerships (MESETA, 2009). Learners need learnership contracts to complete qualifications and reach artisan status. The remaining part of the qualification, initiated with these skills development programmes, can only be completed within a learnership (RSA, 1998b:24).

If learnership contracts cannot be obtained, learners can do only level one of these learnership fractions. A comprehensive (full) level one (NQF 1) and a learnership contract is required to proceed to level 2 (NQF 2) (MERSETA, 2009). Consequently the ability of FET colleges to accommodate and educate unsuccessful school leavers is compromised by limited skills development programmes, lack of education foundation building and inadequate achievements as reflected by the NC(V) examination results shown in Graph 1.4. Another possible option, orientation programmes at FET colleges, was abolished.

These programmes, or short courses, do not address the needs of unsuccessful school leavers. They provide opportunities to acquire skills, but the fundamental educational shortcomings of unsuccessful school leavers that have (*presumably?*) caused their inadequate learning, are not attended to. Languages, mathematics, science, capacity to learn and cognitive development are negated. Lack of proficiency in these areas is a fundamental obstacle in the capacity of unsuccessful school leavers to learn effectively, hampering their development. Such nonformal or short courses are therefore not suitable for unsuccessful school leavers' educational development.

2.5.2 ORIENTATION COURSES IN SOUTH AFRICAN INDUSTRY

Skills courses (pre-learnership training), offered by training providers in the South African industry, prepare learners for learnerships. They do not make provision for improvement in learning ability or fundamental subjects such as language, mathematics and science, with the intention of building a foundation for effective learning (Aucamp, 2011: Telephone conversation 15 March 2011). The items in the pre-learnership training programme list, compiled by a specific company from SAQA unit standards, confirm the purpose.

Table 2.1: Purpose of pre-apprenticeship training

Practical	**Theoretical**
Place a component on a stand	Locate info in system
Company and product orientation	Intro to basic gears knowledge
Practical test	Basic diesel engines
Service reporting	Principles of hydraulics
Measuring	Principles of pneumatics
Take fluid samples	Warranty
Manage a logbook	Service information system

The number of learners needed in engineering learnerships is vastly outnumbered by the number of unsuccessful school leavers – 12 500 to 577 722 annually (RSA, 2008:39; Department of Basic Education, 2010; Parliamentary Monitoring Group, 2010). Youth unemployment figures illustrate the inability of trade and industry to accommodate large numbers in preparatory vocational training. Trade and industry prefer better-qualified people, disqualifying unsuccessful school leavers. These facts reiterate the need for education for unsuccessful school leavers on a larger scale than the current prospects offered by means of skills programmes and **not on demand of trade and industry**.

2.5.3 SPECIAL NEEDS AND REMEDIAL-AND-SPECIAL EDUCATION IN THE RSA

What became evident is a gap in the South African public education system leaving those (unsuccessful school leavers) who do not cope in the current programmes without a second chance in education. The poor success rate of learners in mainstream school and FET college education is evidence of the gap in the public education system. It signifies a need for a specific kind of education that can address the educational needs of the learners that do not respond well in the mainstream programmes. Special education can be considered, but the sheer numbers of unsuccessful school leavers and their poor success rate in vocational education (NC(V)) point towards a situation different from the focus of special (needs) education in South Africa.

The South African public education system comprises General Education and Training (GET), Further Education and Training (FET), Higher Education and Training (HET), Adult Basic Education and Training (ABET), Special Needs Education (SNE) and Remedial-and-Special Education (RemSpecEd). SNE and RemSpecEd do not make provision for unsuccessful school leavers. They specialise in education for disabled children with mental and physical disabilities (Department of Education. 2005a:7, 20, 27). The educational environment in these schools differs from the educational requirements of unsuccessful school leavers.

Addressing the educational needs of unsuccessful school leavers could be established on a level different from special education, between general education and training and vocational further education and training. Van der Berg et al (2011:13) refer to lenient grade progression and the importance of quality education, signifying inadequate general education as one of the factors engendering the educational situation of unsuccessful school leavers. The unfavourable educational situation of unsuccessful school leavers could be relieved with appropriate education.

2.5.4 SECOND CHANCE EDUCATION IN THE INTERNATIONAL ARENA

School dropout is not uniquely South African: it is a universal phenomenon. Communities in other countries deal with the problem of school dropout in different ways because the magnitude of their problem and circumstances differ from South Africa's and their economic situations are different (Chistolini, 2008:222). They have to deal with different rates of school dropout and have different sources of funding to establish and manage second chance schools (CESO, 2000:3; European Commission. 2001:6).

The European Commission initiated actions to reduce school dropout and urged the establishment of second chance schools for 16 to 24 year olds in 1995 (Chistolini, 2008:219).

School dropouts typically experience learning difficulties, neglect, low self-esteem and often have a negative attitude. The second chance schools project, aimed at improving the socioeconomic prospects of these youngsters, includes numeracy, literacy, sports, drama, teamwork and customer service skills in the curriculum. In the education of these people, the Centrum Voor Europese Studies en Opleidingen (CESO) (2000) focuses on key aspects, which are worth considering in this study:

- "A different teaching and counselling approach focusing on the individual's needs, wishes and abilities, and stimulating his/her active learning."
- "Flexible modules allowing the acquisition of basic skills (numeracy, literacy, social skills) to be combined with practical training in and by companies." (European Commission, 2001:6).

These two aspects may be central in the concept of "second chance education" for South Africa. Further elaboration is done in Chapter 5.

The South African situation differs in terms of the ratio, school dropout/school success involved (Graph 1.1; Graph 1.2) and economic status – first world vs. third world. Unlike the situation in Europe and Great Britain, greater government involvement would be necessary in South Africa due to the magnitude of dropout and financial considerations.

2.5.5 SECOND CHANCE SCHOOLS IN EUROPE

Second chance schools were established in Great Britain, Europe and several other countries in the "first world" to give school dropouts a second chance in education and training (Chistolini, 2008:219). These schools are intended to improve the situation of European unsuccessful school leavers by providing opportunities to acquire trade and life skills, pursue life-long learning and taking learners off the welfare budget. These countries are also involved in improving their school dropout situations.

Graph 1.2 shows the results of measures taken by the European countries to reduce school dropout rates. Greece and Italy, two European countries with high school-dropout figures, are succeeding in resolving the problem and making provision for young out of school unemployed (NEET) people (Chistolini, 2008:221). From the European experience, it is evident that education for these learners will be a long-term enterprise. "There will always be the 30% who cannot associate classroom instruction with the real world" (Webb, 2000:1).

Second chance schools in Europe aim at combating unemployment, social exclusion and poverty. Pilot projects ran in various cities in Europe in the period 1997 to 1999: Marseille (France), Halle and Köln (Germany), Leeds (United Kingdom), Bilbao and Barcelona (Spain), Hämeenlinna (Finland), Norrköping (Sweden), Catania (Italy), Athens (Greece), Seixal (Portugal), Heerlen (The Netherlands) and Svendborg (Denmark). Greece, one of the European countries with high school dropout rate and high rates of youth unemployment, established 48 second chance schools (Chistolini, 2008:221; Figure 2.1).

The Commission of the European Communities (European Commission) drafted a White Paper on "Teaching and learning: towards the learning society" in 1995 proposing five priorities:

- "recognise skills acquired over a lifetime"
- "bring schools and businesses closer together"
- "combat social exclusion through teaching and training"
- "proficiency in three Community languages"
- "treat capital investment and investments in training on an equal basis" (Chistolini, 2008:219).

"From its inception, the school in Catania, Italy was meant to reply to the serious situation of social exclusions of residents of the area, i.e. lack of services, economic and social hardship, and scholastic dispersion. One could say that, after about ten years, the school has done a lot to prevent the phenomenon and almost totally eliminate it" (Chistolini, 2008:223).

"The school in Catania is currently offering training, structured as follows:

- basic education (Italian, history, geography, English, Mathematics, Physics, Social Studies, Multimedia, Psychology)
- professional training (workshops)
- on the job training (in a company)
- common activities (cultural, athletic, recreational)" (Chistolini, 2008:223).

Students in this school are primarily (99%) Italian aged 16 to 22. They completed compulsory school and hold middle school qualifications.

The Peristeri school in Greece offers skills training and qualifications required for employment. They adopted the "theory of *Literacy studies*" and the "concept of multi-literacy, understood as the acquisition of basic scientific competency in":

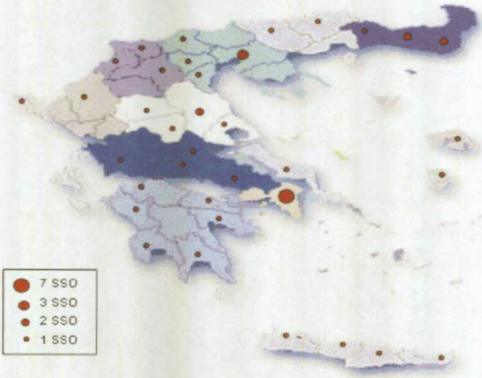
- linguistics (*literacy*) in modern Greek and English;
- arithmetic (*numeracy*) for mathematics;
- computer science (*information technology, computer literacy*) for new technologies (Chistolini, 2008:224).

Physical sciences and multimedia social communications were added to the programme at the school.

The curricula at these two schools constitute the basic educational requirements of school dropouts: improve ability to learn, mathematical skills, scientific skills and linguistic skills. These skills lay the foundation for further education and development. Preparing learners for employment is not confined to lower level occupations. Their second chance education has a vocational focus which suits their situations well. The South African unsuccessful school leaver situation necessitates orientation and preparation for further education with emphasis on re-entry into further education, lower-level skills employment and entrepreneurship.

The second chance school in Catania, Italy emphasises youth employment in their remedial function and they are successful. Peristeri school in Greece adopted a "philosophy of *learn to learn*" which is more concerned with personal development (Chistolini, 2008:225). Personal development is a more "proactive" premise considering capacity to learn fundamental to improvement of the situation.

Figure 2.1: Second chance schools in Greece



(Chistolini, 2008:224: Source: Fragkià A., *La dispersione scolastica e le Scuole della seconda opportunità,* unpublished Master's thesis, Università Roma Tre, Master in Pedagogia per la persona, l'organizzazione, la società, Rome, 2006-07, p. 106).

The situation of unsuccessful school leavers in South Africa is considered to be the result of low-quality education starting with informal education at home (Van der Berg et al, 2011:1). Ineffective education leaves the majority of learners poorly prepared for further education and employment. Contributing to their dismal situation is the absence of appropriate second chance education and the misconception that FET colleges can accommodate them in programmes uncompromising to their educational foundation.

2.5.6 SOUTH AFRICAN EDUCATIONAL REALITY

The reality in South African education is that a majority of learners are unsuccessful in terms of achieving education standards that afford them reasonable prospects of employment, further education or higher education. Against the background of high unemployment, limited access to learnerships, apprenticeships and labour market preferences, school leavers face bleak prospects. It is therefore imperative that the education needs of unsuccessful school leavers should be addressed.

More comprehensive nonformal education programmes, mentioned above, previously an important factor in the activities of technical colleges, are currently insignificant at FET colleges. The magnitude of school dropout provides an opportunity to re-establish the initial focus of technical colleges – upliftment of young people – at FET colleges and address the educational needs of communities.

Ancient Athenian education has a very important message for South African education: *The state can be served best by the individual with the optimal development of his specific talents* – provide diverse education to cater for all. Unsuccessful school leavers' education can be an addition to attainment of that ideal. In Athenian education, change was tolerated and development of the individual was provided for. For the first time, initiative and judgement on the part of the individual was considered to be beneficial to secure rights for all and stability in civil society (Monroe, 1956:52). Optimal development of the specific talents of the individual is to the benefit of society and the state.

Formerly, technical colleges had orientation courses, National Certificate Orientation (NCOR) and before, Elementary Technical Certificate (ETC), for learners who did not have adequate education foundations to cope in the national courses, but equivalent courses were not included in the assortment of NC(V) curricula (Department of Education, 2001:ix).

Contrary to the comments of the Department of Education (2007b:13) that orientation and bridging courses are redundant because "NC(V) programmes eliminate the need for NCOR", the NC(V) 2 curricula do not make adequate provision for learners who have difficulty in coping in the further education and training environment (Department of Education 2007; Department of Education 2007a). They have either to succeed or finally drop out of education without any kind of qualification. Exclusion of these "bridging" courses from FET colleges' programme scope has a detrimental consequence for unsuccessful school leavers, leaving them virtually unprepared for vocationally orientated NC(V) and vocational education (learnerships/SETA education or apprenticeships).

2.6 CONCLUSION

Dropping out of the engineering programmes at FET colleges leaves learners with very limited educational and employment prospects. Cosser (2010), at a Human Sciences Research Council (HSRC) seminar, referred to "the scarcity of further learning opportunities" for unsuccessful school leavers. Another facet of technical colleges' education, comprehensive nonformal education aimed at upliftment of unsuccessful school leavers, has been overlooked in the development of FET college programmes (Department of Education. 1988:249; Department of Education, 2007b:52 – 150).

It is furthermore evident that lower level skills do not feature in the public educational system of South Africa. Learners who do not respond well to the education on offer – school academic, vocationally orientated or vocational (SETA) education – are not catered for. Accommodating such learners in mainstream education does not engender the desired development and progress. Schools' and FET colleges' throughput statistics prove this point (Department of Higher Education and Training, 2009:26, 37 – 41; Graph 1.2, Graph 1.4). Education to suit their needs can put many of these unsuccessful school leavers back on track or improve their prospects – socially and economically.

The overview of vocational education confirms the need for second chance education in South Africa similar to the second chance education in Europe and Great Britain for learners who do not respond well to mainstream education. This kind of education is not necessarily established on demand of trade and/or industry in their quest for skilled manpower. It should be regarded as developmental education unrelated to the needs of trade and industry. Second chance education, specifically vocational education, is (was) often an escape route out of unfavourable situations, e.g. improvement of socioeconomic circumstances. It was done in the early days of vocational education in South Africa and it can be done again, but appropriate curricula need to be designed.

Culmination of the processes in the envisaged curriculum design can be achieved according to a predetermined design or plan. Establishing applicable curriculum design and development principles for appropriate vocational education for unsuccessful school leavers is a prerequisite for the actual process of designing a curriculum. The design or plan is embedded in a theoretical foundation constituting curriculum design and development theories. Underlying the principles and premises guiding the study towards the aim of designing a curriculum, the curriculum design and development theories constitute the fundamentals of curriculum design discussed in Chapter 3.

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CHAPTER 3

CURRICULUM DEVELOPMENT AND DESIGN THEORIES FOR AN UNSUCCESSFUL SCHOOL LEAVERS' VOCATIONAL CURRICULUM

3.1 INTRODUCTION

The vocational education overview, in Chapter 2, established guidelines and perspective on the international and South African vocational education situation. South African education does not make provision for unsuccessful school leavers to improve skills and qualifications through a process of educational foundation construction and capacity building. The magnitude of school dropout in South Africa and the poor employment prospects facing these learners, necessitate serious consideration of curricula to accommodate them. These learners should be *afforded opportunities to escape their precarious socioeconomic circumstances.*

From the information gathered in Chapter 2 it can be concluded that vocational education was regarded as means to social upliftment of people apart from trade and industry demands. Vocational education is also utilised in foreign countries to improve the socioeconomic situation of NEET youngsters by combating unemployment, social exclusion and poverty. South Africa's education system, considering the current programmes, does not make provision for unsuccessful school leavers. Suggesting education to address the meagre educational situation of unsuccessful school leavers requires the design and development of appropriate curricula, but within the means and scope of this study only one specific field of vocational education can be considered.

Education implies a curriculum and all the procedures involved initiated by the theoretical substructures. Incorporated in a general theory, curriculum design and development theories underlie the processes signified (Carl, 2010:21). These processes originate in the theories and differentiate into facets according to the aim of the envisaged curriculum. Focussing on the aim of the study, designing the envisaged curriculum will follow the procedures established according to the relevant theory. Curriculum development will follow similar procedures derived from the development theory founded on the design framework. These procedures, designated to development, will be instrumental in the developmental stage of the curriculation process.

Designing a vocational curriculum to alleviate the meagre educational situation of unsuccessful school leavers in one specific subfield encompasses orientation and a general curriculum theory incorporating the aspects of curriculum design and development. Guided by the outline, the design is based on the data provided by the literature study information, supported by the empirical research data. Assembling all the relevant information coherently in the design and development should culminate in a curriculum with attributes to address the educational needs of unsuccessful school leavers. Formulating the theoretical foundation of curriculum design and development, however, precedes application thereof. These processes are initiated by curriculum orientation.

3.2 CURRICULUM ORIENTATION

Although defining curriculum seems like reinventing the wheel, some aspects deserve reiteration. Hence the following notation: The curriculum is all of the activities of an educational institution to promote the development of the learners in the aspects of human existence (Ross, 2000:9; Carl, 2010:27). Winberg, Engel-Hills, Garraway and Jacobs (2011:13) confirm the comprehensiveness by stating, "[T]he term curriculum includes not only the content of subjects, but how knowledge within a subject is organised, how teachers teach, how learners learn and how the whole is assessed."

It can therefore be concluded that a curriculum is the programme or plan of activities, in this instance, for the education of unsuccessful Grades 9 to 12 school leavers (unsuccessful school leavers) from initiation to assessment. A curriculum will therefore be acknowledged as a planned sequence of learning experiences regarding learning as the construction of declarative and procedural knowledge. Learning, as the very essence of education, should therefore be constructed on a sound fundamental learning theory. Education should acknowledge and promote proficiency exceeding the sum total of the proposed outcomes (Erickson, 1998:113).

Organising the course or path of education (curriculum) was realised long ago according to Doll (2008:190), and in the mid-1500s the word curriculum was first used by an educator, Peter Ramus, in an educational sense. His graphic representation of a curriculum was labelled, Ramist map or chart.

The first step in curriculum design, after the motivation, is orientation, which has a number of focus questions (Parkay and Hass, 2000:1). Fundamental aspects revealed in the research should be addressed, forming the basis for the development of the curriculum. An understanding of the concept, function of a curriculum in education, broad general goal and aim of the curriculum, and what values influence the process, is fundamental to the development (Carl, 2010:17). Curriculum aim and objectives provide the guidelines for decisions like the choice of outcomes, learning content and methodology. Derived from the curriculum aim and objectives, the following focus questions are related to the curriculum design cycle and their purpose is to guide the procedure through the specified facets (cf. 1.4).

- What kind of development needs to be accommodated?
- What is the level of existing knowledge of the candidates (Carl, 2010:66)?
- Which educational approach will be the most efficient in this situation?
- What is the schedule of the envisaged curriculum?
- Which initial outline can be utilised for the curriculum design?
- Where does the envisaged curriculum fit in the educational system?
- What are the curriculum aim and objectives?

These focusing questions signify the objectives to be pursued in the curriculum design process. They should guide the process towards accomplishment of the research objectives and attributes disclosed in the research.

Consequently, the process of designing and developing the envisaged curriculum will be guided by the curriculum, design and development theories.

3.3 CURRICULUM THEORY

Curriculum theory is the all-encompassing account of the domain, aspects and facets of a curriculum and their relationships, including the design and development theories (Collins and O'Brien, 2003:355). Operating on the meso- and micro-levels of curriculum design and development in this study, the concern is the design of a curriculum for vocational education (Carl, 2010:80). As proposal, the final curriculum may be submitted to the authorities who could consider it on a macro-level – completing the process of development: dissemination, implementation and operational evaluation.

Carl (2010:21) emphasises the establishment of a sound curriculum theory: "It is essential firstly to study and develop curriculum theory." He further elaborates on the composition of such a theory: "A unified point of view in regard to what is relevant for everyone ..., but it still remains necessary to give an account of theory and practice on an ongoing basis." On page 22 he elaborates on the importance of the theory: "Curricula must be relevant and developed on an accountable basis in order to comply with the demands and needs of the country and the community." De Villiers's (2001:1) version, "Within the context of the study, a curriculum development model is a symbolic representation of the relationships between specified curriculum development phases, steps and tasks that constitute a curriculum development process", confirms the comprehensiveness of a curriculum and the process of developing one. What she calls a "curriculum model" correlates with Carl's "general curriculum theory". De Villiers (2001:1) posits, "A curriculum model for curriculum development in nursing and the health sciences is discussed. This model establishes a strategy by which curriculum development can be approached comprehensively and systematically. The steps and tasks inherent in the three curriculum development phases, namely planning, design and application are outlined". A curriculum theory can therefore be regarded as an inclusive account of the aim, objectives and procedures of establishing a curriculum. It is prevalent throughout the procedure, from the focus questions and premises to benchmarking of the constructed curriculum.

Complementary to the focus questions are the curriculum premises derived from the curriculum "definition" in 3.2 above, criteria listed in Carl (2010:67-69), Squires (2005:111) and references shown. The following curriculum premises are prerequisites for curriculum design:

- A curriculum is an educational guide to educators and learners.
- A curriculum encompasses educational and developmental activities – knowledge, skills and values.
- A curriculum pursues progress of all learners catered for – realisation of ability as closely as possible to potential (RSA, 1998; European Commission, 2001:6).
- A curriculum reveals awareness of and sensitivity to educational fundamentals and principles.
- A curriculum promotes (*within the capacity of FET colleges*) holistic development of all learners.
- A curriculum pursues relevance and gestalt (wholeness) (Hergenhahn and Olson, 2005:268).
- A curriculum promotes responsiveness to coherence and relevance in learning opportunities, material, media and mode.
- A curriculum makes ample provision for discovery opportunities and stimulates curiosity.
- A curriculum encourages continuous and formative assessment as part of an appraisal system.
- Curriculum design must be in line with curriculum aim and objectives.
- A curriculum includes critical cross-field outcomes (national outcomes).

The curriculum premises set the landmarks and boundaries for the design process towards the aim of the study: a curriculum for unsuccessful school leavers' education. They will feature in the facets of the curriculum design cycle according to the corresponding concepts signified.

Curriculum theory provides for premeditation and orientation towards the comprehensive processes involved in curriculation (Carl, 2010:21). It evolves from a study of curriculation resulting in a better understanding of the processes, domain, aspects, relevance, links, strategies, standards, manifestations in intention, delivery and reception/reflection, and justification. This process of theorisation precedes the praxes of curriculum design and constructing, which are the intentions of the study. Designing and constructing a curriculum for a specific group of unsuccessful school leavers along these lines are pursued.

3.4 CURRICULUM DESIGN THEORY

Curriculum design theory is the account of the domain, nature of the aspects and facets of a curriculum design and their relationships (Collins and O'Brien, 2003:355). Butterfield et al (2003:1672) defines theory as, "a system of rules, procedures, and assumptions used to produce a result." This curriculum design theory concerns the flow of events in a typical procedure of designing a vocational curriculum (the result). It is, however, necessary to establish the denotations of curriculum development and curriculum design according to their application in this study.

Baba (2008:2) distinguishes between curriculum planning (design) and curriculum development: "Curriculum development is a process of moving from plan to implementation, i.e. from theory to practice." De Villiers (2001:1 of 13) regards the developmental phase of a curriculum to be "planning, design and application." Carl (2010:34, 35) posits, "*For the purpose of this publication, curriculum development is regarded as an umbrella and continuing process... It comprises a number of phases: curriculum design, curriculum dissemination, curriculum implementation and curriculum evaluation.*" Carl considers design a process that integrates curriculum plan and curriculum construction/assembly and thereby regarding "curriculum theory" the acquaintance, orientation and perspective to "design" curricula. Carl (2010:35) also mentions, "Another view is that curriculum development comprises phases, such as initiation, development, adoption and evaluation." Another version by Carl (2010:38), "Curriculum design is that phase during which a new curriculum is planned," is aligned with that of Baba (2008) and De Villiers (2001). It is, however, possible to determine the connotations of "development" and "design" within the context given.

There are differences of opinion regarding the concept of curriculum "development", but considering "planning" and "design" facets of the same process, De Villiers's (2001:1) notion is virtually the same as that of Baba (2008:2). In Carl's version of curriculum development, the aspects of dissemination and implementation are beyond the authority and scope of this study. Based on Baba's statement, curriculum design theory will be regarded as the "blueprint" of the processes to be followed, curriculum design the process of planning the curriculum and curriculum development the process of converting the plan into practicable format. This practical approach does not exclude the essence of educational and curricular principles.

Activating the curriculum design is initiated with an outline – curriculum design cycle – incorporating underlying principles. It is accepted that the chosen cycle is appropriate as guide for the design of the curriculum to provide second chance education for unsuccessful school leavers. A curriculum cycle, described in the following section, will serve as outline to guide the endeavour.

3.4.1 ESTABLISHMENT OF THE CURRICULUM DESIGN CYCLE

A curriculum design cycle is described by Lovat and Smith (1995:109), as reported by De Villiers (2001:3 of 13), as a rational and orderly process with "interrelated and interactive actions." Reiterating the orderliness of the process, Carl (2010:70) posits that curriculum design requires a procedure plan "as it may give direction and purpose to the whole process." Carl (2010:64) comments: "Curriculum design is therefore not a fixed recipe consisting of components and fixed rules, but a process characterised by flexibility and pliability within which the specific variables exercise a strong influence." This procedure plan or design cycle provides the outline for the processes involved in curriculum design. Each facet (or stage) of a curriculum design cycle incorporates objectives, criteria, interpretation, evaluation and decision/selection in processes of establishing a curriculum structure. Nevertheless, compiling or selecting a suitable design cycle paves the way for the process of curriculum design.

A curriculum design starts with a multi-faceted, cyclical process in drafting a "route map" for the education ("journey") presumed (Nicholls and Nicholls, 1978:21). Regarding education as a "journey" and curriculum as the "route map," signifies the Latin origin of the latter: *currere*, to run (Butterfield et al, 2003:411). This "route map" should guide educators and learners through the process required to "reach" (achieve) the "destination" (qualification and/or goal) (Squires, 2005:4, 102). It is therefore important to produce a curriculum (route map), which will be efficient in every aspect of the "journey" envisaged. Kern et al (2009:6) refer to the curriculum design cycle as "approach to curriculum development." Nevertheless, in this study 'curriculum design cycle' will be regarded as the outline for curriculum design.

Kern et al (2009:6-8) discuss a six-step approach to curriculum design comprising:

- problem identification and general needs assessment
- target needs assessment
- goals and objectives
- educational strategies
- implementation

- evaluation and feedback

Carl (2010:70-74) refers to and illustrates the curriculum design models of Tyler (1949), Taba (1962), Walters (1978), Kruger (1980), Oliva (1988) and Cawood, Carl and Blanckenberg (Carl, 1986) in emphasising the desirability of "thorough knowledge" of the topic. Krüger and Müller (1990:27) have a six-stage curriculum cycle similar to the Nicholls and Nicholls (1978:71) model. Mostert (1988:8, 9) utilises a comparable cycle.

Although curriculum design cycles differ, they have a common perspective on the essential processes and "sequence" of curriculum design (Marsh, 1993:70-109). "There are a few components or elements, such as those set out below, which seem to be in common amongst most of the curriculum models mentioned:

- Situation analysis/Contextual evaluation/Initial evaluation
- Objectives and goals
- Selection and classification of contents
- Selection of methods, techniques and media
- Selection and classification of learning experiences
- Planning and implementation of the instructional-learning situation
- Evaluation of learners." (Carl, 2010:73)

Nicholls and Nicholls (1978:21) have a cycle, closely resembling the conclusion above. According to De Villiers (2001:3 of 7; Table 3.1), "Nicholls and Nicholls (1978:21) specify the involvement of five curriculum components in their cyclic curriculum development model, namely the situational analysis[(1)], selection of objectives[(2)], selection and organisation of content[(3)], selection and organisation of methods[(4)] and evaluation of learning[(5)]." Nicholls and Nicholls's model differs from that of Tyler in that provision is made for the situational analysis, content is separated from learning experiences, and curriculum design is applied to the components of curriculum content and learning opportunities.

OBE (Spady, 1994:18–20) has a "design down principle" starting at the culminating outcomes. The central questions of Spady's (1998) "design down principle" are also aligned with the common sequence stipulated by Drake, (1998:xv, 6).

- What is the purpose of (unsuccessful school leavers) education?
- What is worth learning (for unsuccessful school leavers)?
- How do learners (unsuccessful school leavers) learn best?
- How do we teach to ensure effective (unsuccessful school leavers') learning?
- How do we know that the learners (unsuccessful school leavers) have achieved

proficiency?

For the purpose of this study, these aspects of the design down principle are only of significance to some of the recurring facets of the cyclical design. It is also necessary to change the question, "What is worth learning?" to "What is worth doing?" and then "What is worth knowing to enhance the doing?" This will emphasise the importance of the kind of competence learners should be able to demonstrate.

Within the guidelines provided by curriculum orientation and the background given above, the curriculum design cycle is compiled. In order to emphasise how learners learn (cognition) and how to accomplish learning as a fundamental concept of education, some aspects of the Nicholls and Nicholls model (1978:21) are rearranged to constitute a seven-facet curriculum cycle. This forms the basic outline of the process: situation analysis(1), formulation of the outcomes(2), selection of the learning content(3), learning theory and methodology(4), teaching strategies and learning opportunities(5), learning assessment(6) and curriculum evaluation(7) (Nicholls and Nicholls, 1978:21; Baba, 2008:2). Although the curriculum cycle is divided into seven facets "starting" with the situation analysis, the development of the curriculum entails interaction between the facets and contribution to the development of one another (Carl, 2010:64).

A seven-facet cycle seems appropriate for this endeavour:

- What is the purpose of unsuccessful school leavers' education? - **Situation analysis**
- What is worth doing? - **Formulation of outcomes**
- What do we teach to accomplish the outcomes? - **Learning content**
- How do learners learn best? - **Learning theory and methodology**
- How can learning be accomplished? - **Learning opportunities, education strategies**
- How do we know that the learners have achieved proficiency? - **Assessment of competence**
- How do we know that the education is aligned with curriculum standards and learning principles? - **Curriculum benchmarking**

This conclusion is summarised and compared with the Nicholls and Nicholls (1978) model in the Table 3.1. They are similar with the exception of the inclusion of a fundamental learning theory and curriculum evaluation as a separate facet. The fundamental learning theory emphasises the very essence of education and supports methodology, learning opportunities and education strategies.

Table 3.1. Curriculum design cycle

Nicholls and Nicholls Cycle	Design Cycle of proposed curriculum
Situation Analysis	Situation Analysis
Selection of Objectives	Formulation of the Outcomes
Selection and Organisation of Content	Selection of Learning Content
Selection and Organisation of Methods	Learning Theory and Methodology
Evaluation of Learning	Learning Opportunities and Education Strategies
(Nicholls and Nicholls, 1978:21)	Learning Assessment
	Evaluation of the Curriculum

Initiating the design with a situation analysis affords the opportunity to get acquainted with and get perspective on the situation without concluding this facet. Nicholls and Nicholls (1978:21) argue in favour of a "more comprehensive approach to diagnoses, an analysis of all the factors which make up the total situation..." Information acquired enables formulation of the outcomes, determination of the learning material, establishing guidance for the learning and discovery opportunities, establishing assessment for learning in a process of constructing and evaluating the curriculum. Continuous benchmarking of the curriculum during development, against the set criteria derived from the research question, curriculum focus questions and principles, is part of the procedure. A cyclical process is an acknowledgement of the integrated continuous nature of curriculum design. The different facets are developed virtually simultaneously.

De Villiers (2001:3 of 13) emphasises that "[a]nother feature of Print's (1993) model is that a clear distinction is made between assessment of learning and curriculum evaluation" – in other words, not just a reference to the cycle, but a clear distinction is made. Another distinctive feature is the dynamics in the process, evaluating the curriculum (for unsuccessful school leavers) continuously during development and also during application. Corrections, amendments and upgrading can be effected when deemed necessary.

The seven facets of the above curriculum design cycle constitute the skeleton of the curriculum design procedure. It should be reiterated that they are not sequential, but cyclical. They are developed virtually simultaneously, restructuring and adding new concepts throughout the procedure. Curriculum design is an integrated, recurring, cyclical procedure. The design cycle for the unsuccessful school leavers' curriculum involves all the facets in the procedure.

3.4.2 SITUATION ANALYSIS OF THE EDUCATIONAL SITUATION OF UNSUCCESSFUL SCHOOL LEAVERS

Power (2010:1 of 1) defines a situation: "A situation refers to the general position or context that a person or organization is operating within at a specific point in time. A situation refers to the general state of things; or the combination of circumstances occurring at a given time." Kern et al (2009:6, 7) initiate their curriculum design with a "problem identification and general needs assessment" in "identification" and "critical analysis" followed by a "targeted needs assessment". It can therefore be concluded that a situation analysis for curriculum design is a procedure of identifying stakeholders and facilities, also assessment of needs, circumstances and conditions. Analysing the situation is rudimentary to the process of information collection, being investigative and inferential in establishing and evaluating the existing state of affairs with the intention of addressing identified problems and needs.

There are primarily three groups of factors contributing to the circumstances of the learners, i.e. educational profile of the learners, internal factors (in-house situations) and broader contextual issues – the main components of the situation analysis (Marsh, 1993:179). "The purpose of the situational analysis is to ensure that the proposed curriculum is relevant to the society that the graduate will serve" (De Villiers, 2001:8 of 13). In the unsuccessful school leavers situation the prime concern is to get the learners back in education in a second chance situation and thereby constructing educational foundations and building capacity to serve their local communities.

3.4.2.1 Learners (unsuccessful school-leavers)

A situation analysis, incorporating a needs assessment, involves associates and participants to ensure responsiveness and reflection of their needs. Information revealing their needs could be obtained by means of surveys, interviews, questionnaires, focus groups and literature reviews (Wong, 2006:952). The inputs of these stakeholders, sharing their experiences, opinions, perceptions and perspectives, are essential in assembling a realistic account of the situation. Questionnaires and interviews were utilised to establish a picture of the unsuccessful school leavers' situation. Official statistics, official reports and information from a literature study provide background, context, fundamentals and basic attributes to the situation analysis.

De Villiers (2001:9 of 13) confirms the importance of the inputs of stakeholders in the information gathering for curriculum design. From this perceptive Wong (2006:952) comments: "Input from the learners, teachers, administrators and support staff helps ensure that the resultant curriculum is responsive and reflective of the needs of those whom it is supposed to serve." The associates in this situation are unsuccessful Grades 9 to 12 school-leavers (unsuccessful school leavers) enrolled in engineering studies. Personnel in engineering studies at FET colleges, who are assigned the responsibility to educate these learners and Faculties of Engineering at FET colleges where the learners are accommodated, are also factors in the situation. Other important stakeholders are the authorities responsible for policy, provision of facilities, equipment and personnel, parents in a supportive capacity and potential employers. Personnel, actively involved in the day-to-day practicalities of the situation, are the prime source of information.

Information regarding these aspects relevant to the learners should cover this facet of the situation analysis. It should have a major impact on the fundamental learning theory, educational approach, education strategies and learning content in so far as the learning ability (knowledge construction) is concerned. The statement of De Villiers (2001:7 of 13), "curriculum, is essentially concerned with knowledge", emphasises the real concern of a curriculum. It can further be inferred that construction of knowledge is accomplished through the process of learning (Jordaan and Jordaan, 2000:283; Collins and O'Brien, 2003:201; Feldman and McPhee, 2008:53; Killen, 2010:2).

3.4.2.2 Current educational prospects available to unsuccessful school leavers

The educational situation of unsuccessful school leavers includes the educational programmes currently available to them because of inappropriate progress on the one hand and the possibility that other factors may cause the problem, on the other. According to the Department of Education (2007b:11, 13) NC(V) programmes render orientation/bridging programmes redundant and make provision for entrepreneurship training. These prospects should be investigated to avoid possible duplication. Involved in the situation, are the personnel in engineering at FET colleges as participants in the basic function of providing education.

3.4.2.3 Personnel

An investigation into the proficiency of personnel is a sensitive matter, which is regarded as belonging to another study due to its comprehensiveness, complexity and format. Personnel are regarded as competent, concerned and dedicated educators with vision and commitment until proven otherwise. Investigating educators' proficiency is only justified if the other factors are proven minor contributors to the lack of progress of learners rendering this study superfluous, but then in a different study.

Provision of a personnel establishment that can manage the learners in engineering at FET colleges and unsuccessful school leavers' education would be the responsibility of the authorities. It therefore renders restructuring of the educational dispensation at FET colleges a matter of policy and allocation, assuming that unsuccessful school leavers education would become their responsibility.

3.4.2.4 Educational institutions and facilities

The anticipation that unsuccessful school leavers education would be allocated to FET colleges is based on their involvement in absorbing of part of the school dropout in vocational education and the assumption that FET colleges have spare capacity in terms of time allocated to facilities and equipment (Smith, 2011:30). "If the classroom and workshop capacity at public FET colleges is efficiently utilised, public FET colleges can, subject to available funding, accommodate more than a [one] million students per annum" (RSA, 2008:50). These hunches and departmental confirmation should be investigated and the results taken into account in the aim of the study.

3.4.2.5 Allocation of an unsuccessful school leavers' curriculum within SA Education

Allocation of unsuccessful school leavers' education depends upon a number of factors, e.g. the required level of unsuccessful school leavers' education; educational approach; type of education; availability of facilities and equipment required. These considerations, incorporated in the other facets of the curriculum design, should be inferred and concluded as soon as the relevant information is available.

The Department of Education (RSA, 2008:50) made provision for additional programme offerings at FET colleges: "Over and above the core offerings, FET colleges must offer other types of programmes such as adult education programmes and skills programmes. These should be determined by the college based on industry and community needs."
This concise account of the educational situation of unsuccessful school leavers is the outline for elaboration on the curriculum and education envisaged for unsuccessful school leavers as a second chance. The attributes of the situation analysis are further elaborated on in the other facets of the curriculum design cycle.

3.4.2.6 Comparable curricula

Consideration of curricula "comparable" to the envisaged unsuccessful school leavers' education in South Africa is necessary to avoid duplication and provide perspective on this kind of education in the country. Foreign educational situations concerning school dropout may differ from the South African situation, but their situation can provide perspective.

European countries established second chance schools to address their NEET situation (Chistolini, 2008:222). Establishment of similar schools may not be a feasible option for South Africa to address the local NEET/school dropout situation, but much can be learned from their 16-year experience.

3.4.2.7 Consideration of educational approaches

An educational approach determines key attributes guiding the broad process in providing a central focus, mode in which learning/knowledge construction will be embedded and ultimate outcome envisaged. Killen (2010:51, 52) distinguishes three approaches in structuring a curriculum framework: content-based, experience-based and outcomes-based approaches. Within these broad frames a number of educational approaches are considered in the situation analysis, working towards a solution to the unsuccessful school leavers' educational situation. An educational approach for the envisaged unsuccessful school leavers' education should emerge from the consideration of different approaches guided by the research results. The selected or constructed approach should address the educational needs of unsuccessful school leavers affording them a route back into further education, employment or self-employment.

3.4.3 FORMULATION OF THE OUTCOMES

According to Killen (2010:54), Spady (1994) defines outcomes as "high-quality culminating demonstrations of significant learning in context". This "definition" is a distinct representation of Spady's exposition of the outcomes-based education "philosophy". Spady (1994:18) distinguishes three broad categories of outcomes: "culminating, enabling and discrete". Culminating outcomes define the competences learners should have acquired at the end of their "official learning experiences" – "synonymous to exit outcomes" (Spady, 1994:18, 95). Furthermore, Spady (1994:18) states, "[e]nabling outcomes are key building blocks" towards accomplishment of "culminating outcomes", and "[d]iscreet outcomes" are "nice to know" curriculum detail or "teachers' favourites."

3.4.3.1 Types of outcome

In this study, the National Critical and Developmental Outcomes will be honoured (RSA, 1998a:36). Outcomes will be considered demonstrations of acquisition of significant integrated declarative and procedural knowledge substantiating purposeful development. Considering Spady's three broad categories of outcome, outcomes are divided into three levels of educational achievement:

- National Critical and Developmental Outcomes

- Curriculum Outcomes (equivalent to Spady's "culminating outcomes")
- Unit Standard Outcomes (equivalent to Spady's "enabling outcomes")

Each learning opportunity should promote the developmental ideals contained in the two upper levels of outcome. The unit standards are constructed around the unit standard outcomes, implying the inclusion of learning opportunities.

Kern et al (2009:51) distinguish outcomes/objectives correlating with the outcome hierarchy selected and Spady's version of it. The notion is lower levels of achievement culminating into higher levels and eventually a qualification/aim.

The selection of outcomes is done within the guidelines provided by the aim, objectives and identified educational needs of unsuccessful school leavers to ensure holistic development of whole persons with the capability of facing the challenges of life (Marsh, 1993:86). From the perspective of Winberg et al (2011:13) the different facets of the curriculum should be aligned with other facets constituting an "aligned curriculum". It can therefore be concluded that in a balanced (aligned) curriculum the outcomes are aligned with the activities and assessment. Assessment instruments should measure proficiency, confirm achievement of outcomes and provide feedback to learners.

Criteria for the formulation of outcomes should be derived from the situation analysis and the national outcomes. The already established critical and developmental outcomes may be a suitable springboard for the selection of outcomes, but appropriate outcomes should be carefully considered. Fundamental to this activity is the research question and objectives, directed by the aim of the endeavour.

3.4.3.2 National outcomes (The critical cross-field and developmental outcomes)

Critical and developmental outcomes are national outcomes relevant and applicable to all education in South Africa (RSA, 1998a:36; SAQA, 2006:1; Killen, 2010:395): "The Critical Outcomes below describe the qualities which the National Qualifications Framework identified for the development of learners within the Education and Training system regardless of the specific area and/or content of learning." These critical outcomes are guidelines in the development of ability to learn effectively, civil responsibility and socioeconomic activity. They lay the foundation for all other outcomes in the different aspects of the curriculum structure: learning/curriculum and unit standard outcomes.

The developmental outcomes denote personal responsibility for development (education) and responsibilities towards society. It remains, however, the liability of educators to initiate, guide and manage the development of learners.

Greater clarity of the requirements specified in the critical outcomes can be obtained by analysing the competences and designating knowledge, skills and values to the outcomes. Easier selection of specific learning and learning content needed to accomplish the outcomes is possible with this elaboration.

3.4.3.3 Curriculum outcomes

Curriculum outcomes denote the competences in terms of knowledge, skills and values (including disposition/attitude) learners should have achieved by the end of the curriculum (educational programme) – culminating outcomes in Spady's terms. These competences should connote features of the critical and developmental outcomes. Formulation of the learning outcomes should therefore originate in the critical cross-field and personal developmental outcomes and substantiated by the situation analysis.

Learning/curriculum outcomes are substantiated and expounded upon by the unit standard outcomes. Unit standard outcomes are accomplished with learning opportunities, each one with its own strategic structure, features and achievements contributing to the development of the competences presented by the national and curriculum outcomes. The knowledge, skills and values signifying the curriculum outcomes should correspond with the level and category of educational development, e.g. orientation towards technical education, bridging for learners lacking knowledge and skills, lower level skills preparation and entrepreneurships.

3.4.3.4 Unit standard outcomes

Unit standards are defined as: "registered statements of desired education and training outcomes and their associated assessment criteria together with administrative and other information as specified in these regulations" (RSA, 1998a:5). Unit standard outcomes constitute the foundation upon which a unit standard is constructed. Four to six outcomes are practicable for a unit standard containing the knowledge, skills and values required for the competences intended (SAQA, 2000:36). They define the achievements to be accomplished in practica. A number of learning opportunities will be needed to attain a credible unit standard that can contribute towards a qualification.

Unit standard outcomes must contain the skills learners need to demonstrate, supportive knowledge for calculated execution and values incorporated in the exercise. Knowledge and skills can include transfer of knowledge, critical thinking and innovation, signifying extended acquisition of knowledge. The status of these qualities is revealed in the assessment criteria.

The importance of well-formulate outcomes is affirmed by Kern et al (2009:44). A well-formulated outcome includes five basic elements: "Who – will do – how much/well – of what – by when?" An outcome, in writing, comprises a verb, noun and "conditions of performance" (Spady, 1994:2; SAQA, 2000:43; Kern et al, 2009:44). Outcomes are about what learners can do after accomplishment of the competences described. These differentiate into "knowledge, skills and values." Unit standard outcomes are "road signs" confirming the right track en route to accomplishment of the unit standards and eventually the curriculum aim.

3.4.4 SELECTION OF LEARNING CONTENT

Learning content is the information required to attain the declarative and procedural knowledge, signifying the *knowledge, skills and values,* for accomplishment of the competences specified in the outcomes. From the perspective of psychological learning theories, learning is an information-processing activity (Woolfolk, 2010:237) and therefore learning content will be the information required in the mental processes involved in knowledge construction. The constructed knowledge should correlate with the intended competences in the outcomes. A "curriculum, is essentially concerned with knowledge", more specifically acquisition of knowledge extracted from the learning content (De Villiers, 2001:7 of 13). Although competence does not require complete acquisition of the learning content, planning operates on the ideal situation incorporating all of the learning content.

Determining the learning content of a curriculum is a process of analysing the outcomes and differentiating them into knowledge, skills and values required to develop the competences described (Wong, 2006:954). Attainment of the knowledge, skills and values is a process of constructing declarative and procedural knowledge from the information presented in the form of learning material. Learning materials are the sources containing the required information (learning content). Being the substance of learning, learning content is fundamental in any learning opportunity.

Learning material comprises the course (subject) guides, study guides/unit standards, course (subject) notes, textbooks, course (subject) specific charts, drawings, videos, films, models and projects containing the desired knowledge. They can provide the information needed for construction of declarative and procedural knowledge contained in the competences, represented in the outcomes (Sternberg, 2003:248, 270). The learning content of the course or subject denotes the information requirements.

Selecting the learning content inevitably involves selecting the sources that can provide the content (information) for the learning opportunities. The knowledge, skills and values learners need are the criteria for selection of the sources of the required information – learning material with the potential to disclose the information required for accomplishment of the outcomes.

3.4.4.1 Criteria for learning content selection

Criteria for the selection of learning material are derived from the critical cross-field, personal developmental and curriculum outcomes, complemented by the features disclosed in the research. Knowledge, skills and values (declarative and procedural knowledge) are fundamental in the learning material criteria. Learning material with the potential to reveal the required information and facilitate construction of knowledge must meet specific criteria. The criteria for individual learning opportunity material will not necessarily incorporate all the criteria in a single opportunity, but they will be covered in the course of the programme.

Interpreting the data and analysing the identified tasks contribute a great deal in selecting appropriate learning content to match the objectives set in the outcomes (Finch and Crunkilton, 1979:110). Ensuring quality, coherence, relevance and compliance with education principles can be achieved by benchmarking the selected learning material and applications in learning opportunities (cf. 6.3.4.3). Benchmarking the learning material against the required learning content and essential features will prevent the occurrence of missing links in the information and consequently hampering construction of declarative and procedural knowledge, i.e. the establishment of knowledge, skills and values (Krüger and Müller, 1990:60, 61).

It is the responsibility of the educators to select and compile learning content based on the core content given in the curriculum and unit standards. Carl (2010:31) points out, "[L]earning content is found in detail in textbooks, subject literature, self-activity modules, various educational media and others." Learning must be real integrated experiences of declarative and procedural knowledge construction. Learners should construct relevant declarative knowledge while they are executing the task, thus constructing procedural knowledge. The learning content encompasses the following characteristics:

- Linked to prior knowledge – built on a foundation of existing mental representations
- Represents integrated declarative and procedural knowledge
- Distinctly identifies the declarative and procedural knowledge represented
- Be comprehensive enough to satisfy the requirements of breadth and depth enabling accomplishment of the different levels according to Bloom's revised taxonomy of learning outcomes (cf. 4.3.1)

Feldman and McPhee (2008:137, 138) mentioned two approaches to learning opportunity (lesson) planning: content approach and process approach. At this stage the importance of content should be clear, but the process is equally important. Feldman and McPhee (2008:138) focus on the processes to enhance learning in the process-oriented approach and thereby denoting teaching. Process-oriented approaches utilise the process as outline to construct a learning opportunity incorporating learning material in the processes. Content-oriented approaches utilise content as outline and construct learning opportunities and concomitant processes around it. The orientation is of less concern and will eventually be determined by the kind of education and the material at offer. It is a matter of aligning outcomes, core content, learning content and procedure.

3.4.5 FUNDAMENTAL THEORY AND METHODOLOGY

3.4.5.1 Fundamental theory for unsuccessful school leavers' education

Learning is the purpose and central activity of education – the very essence of education irrespective of declarative or procedural knowledge construction. Mental and perceptual-motor development is embedded in cognitive processes denoting learning (Feldman and McPhee, 2008:93). It is therefore imperative that learning be the fundamental theory in education. Educators are concerned about how learners learn and how learning can be facilitated, which can be comprehended through an appropriate learning theory. Decisions about a curriculum are based on the nature of knowledge, the learner and the fundamental learning theory (De Villiers, 2001:2 of 13).

How learners learn provides fundamental information for educational approach, planning and practice (Killen, 2010:8). It enables educators to exploit specific features enhancing the cognitive processes and to avoid negative elements[1] and unintentionally obstructive behaviour in presentations. Effective learning relies on presentations correlating with the natural mental processes of learning. Adding vividness and richness to learning content enhances perception, conceptualisation and memorising of information.

3.4.5.2 Fundamental learning theory related to unsuccessful school leavers situation

Facilitation of effective learning is an art with a variety of methods and techniques guided by educational principles and premises constituting educational modality. It is, however, the fundamental theory of learning that underlies all of the education constituting a curriculum and the effective learning required to accomplish the desired competences. Wong (2006:955) states the dominance of learning theories in "instructional and curricular design". It is the fundamental learning theory that provides the essence of educational processes to follow. This

[1] Negative elements, e.g. unrelated or contradicting information, inappropriate associations

theory, discussed comprehensively in Chapter 4, is the foundation upon which unsuccessful school leavers' education is constructed.

The concomitant education and the curriculum should be founded on a psychological learning theory providing answers to the crucial questions about education (cf. 3.4.1). How learners learn can be derived from the fundamental learning theory and presentation of the learning material constructed upon these fundamentals to address educational needs of unsuccessful school leavers. Effective education is the basis of development unsuccessful school leavers desperately need. Elaboration on the educational aspects of the curriculum is done in Chapter 5.

3.4.5.3 Methodology compliant with fundamental theory (Educational strategy)

Methodology is the art and science of education guiding the praxis. It manifests in the classroom activities predetermined in the strategies, which in turn is constituted with methods, techniques and tactics. Methods and techniques utilised for learning opportunities differ on account of the underlying learning theory and their differences in educational approach (cf. 4.5). The fundamental learning theory provides the principles, premises and guidelines for establishment of an appropriate approach and educational strategies.

3.4.6 LEARNING OPPORTUNITY DESIGN

3.4.6.1 Learning opportunity – the concept

From Carl (2010:93, 94) it can be concluded that learning opportunities are events to which learners are exposed. These environments and proceedings, created by educators in their capacity of facilitators, afford learners opportunities to get actively involved and construct their own mental presentations of the learning content presented. Creating these environments requires careful planning and preparation well in advance.

3.4.6.2 Learning opportunity design and design cycle

Learning opportunities are formally scheduled events where learners have prospects of constructing knowledge, acquire skills and develop values (declarative and procedural knowledge) in venues specifically prepared for the learning content to be mastered. Educators are responsible for the planning and development of the learning opportunities in accordance with syllabi, curriculum statements, study guides and/or unit standards (Killen, 2010:86). Teaching strategies are the educators' domain within the learning opportunities.

Reading (interpreting) the route map (curriculum), establishing the conditions (situation analysis) planning the journey (opportunity design) and undertaking the expedition (learning opportunity) involve similar stages or facets incorporated in a curriculum design cycle. Every learning opportunity is a journey in its own right with a point of departure, an expedition and a destiny. Each one must be developed, going through all the stages of the opportunity design cycle starting with the situation analysis (Krüger and Müller, 1990:24; Solomon, 2003:81). Utilising an equivalent to the curriculum design cycle for learning opportunity design affords a structured cycle comprising the facets required. Standardising the learning opportunity design cycle can enhance learning opportunity planning and ensure inclusion of the required elements and procedures.

Learning opportunities are designed utilising a similar cyclical process as that implemented for the curriculum: *situation analyses, *interpretation of outcomes, *learning content, *learning theory and premises, *presentation strategies, *assessment of learning, *venue preparation *opportunity benchmarking[2]. Learning opportunities have the same principles as those applicable to the curriculum. It is therefore essential that the learning opportunity design cycle correlate with the curriculum design cycle. Learning opportunities, being shorter "journeys", taking the educational process (the entire "journey") towards its culmination, require the same deliberations (Krüger and Müller, 1990:24-28).

The fundamental learning theory is the prime contributor to the formulation of the education principles and premises (cf. 6.3.4.3). Educational principles and premises are didactically orientated statements focussing the educational process (learning) on the learners and presentations by the educator. Focussing on the very essence of learning they underlie the essentials of education and aptness of the educator. They are further discussed and formulated later in the study.

3.4.6.3 Presentation strategy – the concept

Presentation strategy is all of the methods, techniques and tactics constructed for the envisaged learning opportunity. A strategy is a scheme and approach described by Butterfield et al (2003:1595) as "the art or science of ... planning and conduct of... ", but in this study it is the science of planning and conducting education, involving methods, techniques and tactics.

"[A]ll good instruction," according to Feldman and McPhee (2008:418), "incorporates and balances" content, process and context. *Content* is the information learners construct their knowledge from through a *process* of (teaching and) learning in a *context* comprising a learning environment and participants. The latter bring culture and atmosphere (mood) into the learning opportunity.

[2] *Learning opportunity design cycle

Learning content does not constitute learning and education. All three elements, content, process and context must be present in "right and healthy" relationship ("harmony") for the process to "administer" the content in an environment conducive to learning. Carl (2010:93) states that "a particular situation" (context) must be created for the process ("ways, means and actions – methods") to "acquaint the learners with the content in a manner that will lead to learning."

Regarding content as the "vehicle" to help achieving lesson outcomes, Killen (2010:143), signifies the distinction, information (content) and knowledge, skills and values (outcomes). Converting the content (information) into outcomes (knowledge, skills and values) requires a process, learning, in context and an environment (learning opportunity). On this underlying perception, content, process and context are discussed.

In regarding education as a journey, a number of factors require thorough consideration. When the destination (outcome) is known, the point of departure (internalised pertinent knowledge) is of prime concern for the journey to have direction, meaning and relevance (Solomon, 2003:93). With these two aspects known the "journey" can be planned considering approach, route, means, mode and manner, representing the strategy.

3.4.6.4 Method, technique and tactic

Presentation strategy encompasses all of the methods, techniques and tactics the well-prepared strategist (educator) has in his arsenal of declarative and procedural knowledge to accomplish the learning opportunity aim and objectives. Developing this stratagem (operational plan) paves the learning route for the learners to accomplishment of the outcomes. With a well-planned *modus operandi* an educator can enter a learning venue with confidence (Killen, 2010:85).

An important consideration in learning opportunity planning, on the other hand, is how to present the material to the learners for optimum exposure of information, pleasant experiences and effective learning (Spady, 1994:14, 15; Killen, 2010:60). Methods and techniques can be selected to suit specific objectives (Joyce and Weil in Lee and Zeldon, 1983:199, 200). The utilisation of the material is just as important to successful learning as the learning content. Offering practical, hands-on, education brings about differences in methods and techniques and a different challenge in the maintenance of discipline. Methods and techniques should be selected with all the contributing factors in mind.

Contributing further to the experience of the "journey" is the approach, methods and techniques utilised by the "leader" and the reaction or lack thereof by the "participants". A realistic timeframe is also essential, because "late arrival" implies deviation or other difficulties experienced, which necessitates investigation and remediation.

For a comfortable, successful "journey", the means, mode and realistic time schedules are indispensable. A comfortable educational "journey" is the least that should be expected. It should be a pleasant experience for the majority, and it should also be a valuable experience, contributing to the progress of the "journey" (acquisition of knowledge and skills) (Skilbeck in Lee and Zeldon, 1983:18). Kremer (2005:32) posits, "Education should be a journey of discovery..." The "journey" cannot meet these expectations if the means (facilities, equipment, learning material and media) do not meet the requirements of the endeavour. A journey can only be as comfortable as the means, the paraphernalia (presentation) and the road (facilities) allow.

3.4.6.5 Assessment in learning opportunities

Confirmation of "arrival" (assessment) at the correct address denotes a successful "journey" and achievement of the objectives, outcomes and eventually the aim of the learning opportunity. Feldman and McPhee (2008:237) posit, "Assessment is the gathering of data to inform both instructor and student about the progress of learning." This signifies the importance of "milestones" in the curriculum schedule indicating the progress made along the "route" to the "destination" (aim). Benchmarking achievements against the desired progress informs both parties about the state of affairs.

Classroom assessment comprises summative and formative assessment. Summative assessment contributes towards a programme or subject mark accumulating until final judgement. The function of summative assessment is therefore to gather information about learners' achievements, effectiveness of programmes and more remote aims (Department of Basic Education, 2011:27).

Formative assessment is described by Killen (2010:369) as a method to gain information about learners' progress for the purpose of improving learning and necessity of remedial steps. It informs learners about gaps in their "knowledge, understanding or skills and guides them towards closing those gaps". This form of assessment is typical for inclusion in the activities of learning opportunities.

Learning opportunity assessment exceeds the confines of pen-and-paper tests and demonstration of competence in hands-on activities. Feldman and McPhee (2008:259) call it "assessment while you teach". Continuous observation and oral questions can evaluate, guide, stimulate or re-engage learners in the proceedings. This form of assessment should be incorporated, in a well-formulated format, in the learning opportunity design.

3.4.6.6 Venue preparation

Preparing a venue for a learning opportunity is an essential consideration in opportunity design. That represents virtually the "road" (facilities) for the "journey" (learning opportunity). Experiencing a poorly prepared learning opportunity venue can be as uncomfortable as travelling along a poorly constructed road.

A learning opportunity venue must comply with the planned activities ensuring smooth running of the event. That can only be accomplished when the preparation is done in advance.

3.4.6.7 Opportunity benchmarking

Opportunity benchmarking is an evaluation of the entire learning opportunity against predetermined criteria. It comprises three levels of evaluation (assessment): management, peer and self. Benchmarking is essential to identify weaknesses, shortcomings and mistakes for the sake of improving learning opportunities. Criteria are normally predetermined by management, but educators can develop their own rubrics.

3.4.7 ASSESSMENT OF LEARNING/COMPETENCE

An essential part of a curriculum is the assessment and recording of the progress and achievements of the learners (Carl, 2010: 34). Diverse assessment, involving more than the accumulation of credits, should be incorporated. How do we know that the learners have achieved the knowledge, skills and values implied by the outcomes? How do we know that the learners have achieved proficiency? Competence should be proven and include ways and means of achievement.

Educational assessment is a process of collecting conclusive information about the knowledge, skills and values – declarative and procedural knowledge – learners can demonstrate and assigning value to it (Wong, 2006:956). To what extent it represents the true capacity of the learners, is debateable, but with thorough deliberation, careful design of the instruments and a favourable atmosphere during execution, the results can be valid. Instruments need to meet criteria and assessors and moderators must be objective, consistent and committed. Educators need to know the capacities of their learners and level of achievement for grading and possible promotion purposes.

Winberg et al (2011:41) give basic criteria for assessment by stating that, "Assessments should be appropriate, fair, transparent, formative as well as summative, valid, authentic, and consistent." Assessment criteria based on these values are included in the unit standards. The knowledge, skills and values learners are supposed to achieve are extracted from the relevant outcomes constituting the skeleton of unit standards.

Continuous assessment of knowledge and proceedings must ensure that the whole process is evaluated and not only the final outcome – how the different steps (operations) are performed (how they are achieved). Calculated execution of tasks is important. Woolfolk (2010:494, 495) describes assessment as "broader than testing because it includes all kinds of ways to sample and observe students' skills, knowledge and abilities." After each learning or discovery opportunity measurable improvement in knowledge, skills and values should be demonstrated by the learners.

The progress revealed should exceed the confines of lateral development representing only an increase in the volume of knowledge. Higher levels of cognitive development, according to Bloom's revised taxonomy, of are essential for accomplishment of the critical outcomes and the significance of learner development (Forehand, 2005:3; cf. 6.3.1.1.1). Developing a framework of values should manifest in the way learners reflect on assignments, their attitude, interpersonal relationships and the way tools, equipment and material are handled. These adopted attributes form part of the proficiency that learners need to demonstrate.

Proficiency demonstrated by learners must incorporate application of the acquired knowledge and skills in other similar and differing situations. This will ensure construction of knowledge and acquisition of skills. They have to demonstrate competency in the skills in a number of different applications – be able to transfer the knowledge and skills to other situations in solving appropriate problems. The ability to come up with new ideas, new concepts and inventions will prove accomplishment of one of the principles of holistic education: the whole (proficiency) is more than the sum of the constituent parts (portions of internalised knowledge from learning opportunities). "Having learners do important things with what they know is a major step beyond the knowing itself" (Spady, 1994:2).

3.4.7.1 Assessment categories

Assessment is divided in two major categories: summative assessment contributing to a decisive value for endorsement of achievements, and formative assessment reflecting on the state of learning for promotion of correctional steps and further learning (McMillan, 2007:17). Although these two categories of assessment have distinctive purposes, their educational consequences overlap. Formative assessment normally contributes to learning and substantiating knowledge. Summative assessment, on the other hand, contributes towards confirmation of knowledge constructed and competences achieved, but also have formative value.

3.4.7.1.1 Formative assessment

Formative assessment (educative assessment) is a teaching strategy that educators use to determine the state of learning in terms of knowledge acquisition, comprehension and competence during the presentation (Woolfolk, 2010:495). When there is immediate feedback, steps can be taken to rectify misconceptions and/or improve the learning process. Monitoring learning progress continuously keeps educators and learners informed and involved in the classroom or workshop activities (Garrison and Ehringhaus, 2007:1 of 3).

Winberg et al (2011:42) regard observation as another aspect to formative and continuous assessment. They posit, "...teachers are engaged in formative assessment in the classroom, by responding to questions, asking questions and interacting with students during learning activities." The type of formative assessment utilised depends on the intention – what the educator wants to achieve. Verbal questions are the most versatile, but with these it is difficult to accurately gauge progress, comprehension or competence. Some form of recording is necessary to exploit the full value of less structured forms of formative assessment. Rubrics with well-defined criteria and descriptors enhance observation and other forms of formative assessment recording.

Observation comprises various facets including participation, progress, methods utilised, application of safety measures and mechanical procedures, peer interaction and dedication. Various rubrics are necessary for effective recording of observations made, but reducing the task to manageable size requires selection of the most significant to learner development.

3.4.7.1.2 Summative assessment

Summative assessment is essentially part of the curriculum structure. It provides scores or ratings that give an indication of the competence of learners upon which promotion to a higher level or qualification is based (McMillan, 2007:9). Summative assessment is applied at the end of a learning opportunity, an educational term or programme, to confirm the extent of knowledge and competence achievement (Garrison and Ehringhaus, 2007:1 of 3). In unit standards-based education, these achievements can be benchmarked against the requirements of the relevant outcomes and recorded on rubrics.

3.4.7.2 Assessment instruments

Performance, progress and achievement all have various facets, knowledge, skills and values, to be considered. Knowledge, skills and values denote declarative and procedural knowledge each with specific attributes that require a specific focus. Declarative knowledge – *knowing that*, generally facts, concepts, ideas, principles and theories that learners need to know – can be measured with instruments measuring informational (declarative) knowledge construction. The procedural knowledge involved in these measurements is normally taken for granted and not measured explicitly with the exception of specific subjects, e.g. mathematics and science, where procedure also may have value.

Performance, progress and achievement in procedural knowledge (skills, strategies, procedures and values) are evaluated with different instruments. The demonstration of performance, progress and achievement are normally rated according to a predetermined scale because the assessment (evaluation) is primarily based on observation, interpretation and judgement. The declarative knowledge involved is integrated in the procedures and not separately assessed, but it contributes to the competence demonstrated, also in the calculated execution of tasks. Procedural knowledge assessment is a time-consuming, complex task requiring extensive assessment skills. Well-designed rubrics specifying dimension, criteria, scale and descriptors can alleviate the burden of interpretation and judgement and contribute towards fairness, validity and reliability (Department of Education, 2005:29).

Assessment implies measurement of performance, progress and achievement. To measure these qualities instruments are needed. Various instruments can be developed, each one with specific characteristics that suit specific objectives. Educators must determine what they want to measure, why they want to measure it, how it will be measured and what they want to do with the results – establish specific objectives. According to these guidelines suitable instruments can be developed. A number of assessment tool types are given as examples (Van der Horst and McDonald, 1997:176):

- Traditional question and short answer (pen-and-paper tests)
- Object identification ("Pandora's Box"[3])
- Task performance assessment
- Project assessment
- Essay writing
- Fill-in-the-blank-spaces
- Multiple choice
- True or false (Correct or incorrect)

[3] Box full of "evils" if knowledge is lacking (Greek myth). Pandora, first woman on earth created by Hephaestus, opened the box full of evils, given to her by the gods, impelled by her natural curiosity and all evil contained escaped and spread over the earth.

- Matching questions and answers
- Complete the sentence

Winberg et al (2011:44) mentioned "[d]emonstrating knowledge and understanding" as one of their modes of assessment with a range of ways to do just that, but they include "work-oriented assessment tasks" in their scope. In unsuccessful school leavers' terms that can translate into project and procedure assessment in the knowledge and capacity building endeavour of unsuccessful school leavers' vocational education.

Educators can design instruments to provide what they want to achieve. More than one objective can be achieved with innovative instruments. A multiple-choice test for written project assessment (how do you...?) can contribute significantly to learning if an invalid or wrong statement must be identified and the other items in the list are correctly formulated key aspects of the relevant item or process. Learners are forced to read all the statements in the list and evaluate them before they can select the invalid one and thereby can learn a number of valid conclusions while doing the test.

Credibility, validity and reliability can be achieved with specific criteria, aimed at these attributes, for the development of assessment instruments. Credibility, relying on validity and reliability, refers to the quality of belief or trust of educators and learners in the relevant instrument.

Validity is the norm based on the criteria determining relevance, focus, objectivity, accuracy, and logic: the instrument has to measure what it is supposed to measure; it must measure the stated objectives; the assigned score or scale value must correlate with outside references; it must correspond with other significant variables; and it must make sense to field experts (Feldman and McPhee, 2008:243).

Reliability denotes consistency of assessment instruments (Feldman and McPhee, 2008:243). Killen (2010:351) states that an instrument, in a "strict measurement sense, reliability refers to 'the degree to which test scores are free from errors of measurement'." It must consistently achieve corresponding results with the same group of learners. Questions must be unequivocal, ensuring only one correct answer. Different interpretations of the same question due to poor definition or ambiguity render that question, and therefore the instrument, unreliable. Responses to different questions must not reveal contradictions in concepts, notions or definitions. Measuring the same learning content with different instruments must yield comparable results – the educator must be able to come to the same conclusions (Department of Education, 2005:27).

Assessment instruments, whatever type, should comply with the standards, be aligned with the curriculum, meet the requirements of the outcomes and comply with the set criteria. Designing and developing assessment instruments is the responsibility of educators.

3.4.8 CURRICULUM BENCHMARKING

According to Butterfield et al (2003:152) "a benchmark is a criterion by which to measure something and 'evaluate' (assess) the worth (p 567)". From Carl's (2010:140) perspective evaluation "relates to a qualitative broad value determination". Wong (2006:950) posits, "Curriculum evaluation is used to judge the curriculum's merit and worth." Wong (2006:957) further regards curriculum design "a cyclical iterative process which is informed and changed by curriculum evaluation". Carl (2010:160) reports, "Pratt (1980: 410-13) mentions that the completion of the design phase should be followed by its submission to persons of authority who may make recommendations." Establishing the worth of the unsuccessful school leavers' curriculum is therefore evaluation against a set of predetermined criteria, i.e. benchmarking.

Benchmarking of the unsuccessful school leavers' curriculum is limited, due to the academic nature of the study, to an evaluation before, during and after the design phase (Carl, 2010:148). The nature of this study renders the curriculation process academic in approach excluding dissemination, implementation and "after implementation phase evaluation" (Carl, 2010:40, 148). It is therefore a process of evaluating the worth of the unsuccessful school leavers' curriculum against a set of predetermined criteria. The criteria render evaluation of the curriculum the status of benchmarking to determine whether it can achieve its prescribed aims and objectives (Drake, 1998:147).

Wong (2006:958) distinguishes between two forms of curriculum evaluation similar to assessment of learning: formative and summative. Formative assessment occurs during the design and development stages of the curriculum. Summative evaluation occurs during the implementation stage, but adding the curriculum development stages of Carl (2010:35), it should occur during dissemination, implementation and operational evaluation of the curriculum. Wong (2006:958) concludes that both forms "helps inform whether the curriculum is meeting the needs of the stakeholders as well as make recommendations for improvement."

Evaluation of the curriculum is done in three phases: the design and development phase, the external evaluation phase, and the operational evaluation phase. Carl (2010:141) confirms multiphase curriculum evaluation by pointing out that it is prevalent in "curriculum outcomes, development events and the thinking which precedes the events." Finch and Crunkilton (1979:247) emphasise the importance of a systematic evaluation of the curriculum, integrated in the curriculum development. Their evaluation scheme includes two facets for the developmental stage and two for the operational stage, each with its own guiding questions.

It is evident that curriculum benchmarking should be an integral part of curriculum design to guide and judge the process throughout the design cycle. Guiding the curriculum design process, continuous benchmarking against the established criteria can keep it within the confines of the aim and objectives. Designing the curriculum according to the design cycle is a recurring process because every facet influences and is influenced by the other facets. One facet (stage) is not completed before venturing into the other. As contributing parts to the whole, each one must be compared and aligned with the other, the objectives, outcomes and aims to ensure right and healthy relationships and achievement of the standards.

A list of criteria is formulated and compiled into a framework against which the curriculum is benchmarked. Compiling a set of questions can facilitate the formulation of the criteria for the evaluation (Drake, 1998:147, 148). Wong (2006:950) rightly states: "The findings and recommendations from these evaluations feed back into the curriculum development cycle for further curricular improvements or modifications." This feedback redirects and guides the curriculum design during the design stage.

3.4.8.1 Design benchmarking

Guided by the criteria listed in Carl (2010:160) and Drake (1998:148), benchmarking criteria are developed for continuous benchmarking and external benchmarking. Based on the aim of the study and the information acquired from the literature study and empirical research, benchmarking criteria were formulated to ensure inclusion of the desired attributes.

A clear distinction is made between learning assessment and curriculum evaluation, giving the curriculum design a dynamic characteristic (Carl, 2010:98). Continuous benchmarking against the standards set, aligns the process during the development of the curriculum (Drake, 1998:147, 148). After dissemination and implementation curriculum benchmarking should continue through the lifespan of the curriculum to eliminate shortcomings, misconceptions and time allocated (Wong, 2006:951). The latter is, however, excluded because the procedures of dissemination and implementation fall outside the authority of this study.

3.4.8.2 External Benchmarking

For the sake of feasibility and credibility, a panel evaluation can be done by curriculum experts or training experts in industry to benchmark a vocational curriculum. Group judgement does not only provide perspective to the developer, but can predict the feasibility and credibility of the curriculum.

3.4.8.3 Delphi method of evaluation

The Delphi method is a group evaluation process where the opinions and judgements of experts on a particular subject, problem, curriculum, education model or prediction are collected in support of the decision by the researcher, designer, author or scientist. Named after the Greek oracle at Delphi, it was developed in the 1950s by the RAND Corporation in Santa Monica, California while working on defence research (Yousuf, 2006:1 of 6).

Although the Delphi method was developed to forecast tendencies and science or technological foresight, the technique is also suitable for the evaluation and re-evaluation of a curriculum to determine its feasibility and credibility. Feasibility and credibility evaluations "forecast" the practicability of the curriculum.

3.5 TRANSLATING CURRICULUM DESIGN THEORY INTO CURRICULUM DESIGN

Curriculum design theory can find application in the design of a curriculum. Providing the outline of the process, premises, objectives and aim of the design, the curriculum design theory guides the design towards accomplishment of the product, a practicable curriculum. Limited by the constraints of this study, curriculum development was confined to curriculum design and benchmarking.

3.5.1 CURRICULUM DESIGN

Carl (2010:26, 28) states that such a "dynamic and complex concept" as "curriculum" be clarified to "improve understanding of the whole process of curriculum development". It is therefore necessary to establish perspective on the concept before venturing into the exploration of means, mode and manner of curriculum design. Consequently, the literature study incorporates curriculum design as well as features to accomplish the aim: a transdisciplinary mechanical skills curriculum. In this study the process of "curriculum development" is confined to curriculum design theory and curriculum design (cf. 3.4) (Baba, 2008:2; Carl, 2010:34, 35).

Feldman and McPhee (2008:142), in a metaphorical explanation, point out the "needs of the clients", "know the options", "methods of delivery", "experiential plans" and "measurement of competence" in course (curriculum) design. These metaphors translate into premises signifying the themes of the literature study for this curriculum design, constituting the educational needs of unsuccessful school leavers, the options available, options possible, strategies, learning opportunities and assessment.

Focusing the curriculum to be needs specific, reduces the cohort of learners to the specific target population of unsuccessful school leavers and focuses the literature study on learning theories, educational approaches, strategies, learning opportunities and assessment appropriate for the requirements. Deduced from the learners' lack of educational achievement, the curriculum should promote foundation and capacity building, representing a significant facet of the literature study.

How the envisaged curriculum will be accommodated in the education structure of South Africa is a consideration that depends on its rationale and significance. When learners "disappear" from the educational scene, it suggests a deficiency and/or limitation in the system. Finding and "filling" that "gap," more than determining the efficiency of the current education system, is within the focus of the study. Interest in the preceding education of unsuccessful school leavers is limited to the establishment of the shortfall in the educational foundation of these learners.

The research can confirm a "gap" (shortcoming) in education provision, pointed out by Smith (2011:30), assuming a lack of remedial and/or bridging programmes for addressing the educational situation of unsuccessful school leavers. A positive outcome can support Cosser's (2010) comment about the scarcity of further learning opportunities for unsuccessful school leavers, but would also signify the importance of providing additional (second chance) education.

The curriculum design follows the design cycle formulated in the curriculum design theory comprising a situation analysis, formulation of the outcomes , selection of learning content, learning theory and methodology, learning opportunities and education strategies, assessment of learning and curriculum benchmarking. In the situation analysis the inferences and much of the triangulation is incorporated.

Focusing the curriculum to be needs-specific, reduces the learners to the specific target population of unsuccessful school leavers and confine the literature study to educational approaches, strategies, learning opportunities and assessment appropriate for the requirements. Deduced from the official statistics, revealing the unsuccessful school leavers' lack of educational achievement, the curriculum should promote educational foundation construction and capacity building.

3.6 CONCLUSION

A curriculum design theory, constituting the attributes required for curriculum design, was formulated and discussed. Converting from design theory to design (execution) is based on an outline of the curriculum design process, a seven-facet design cycle that will facilitate the construction of a vocational curriculum. Taking the attributes, discussed in the design theory, into consideration the essential elements will be incorporated into the curriculum to constitute an integrated whole, a vocational curriculum for unsuccessful school leavers.

Designing a curriculum is a process of planning, deliberation, constructing, evaluating and repetition of all the mentioned processes. It is a recurring process of constructing the facets of the design cycle, signifying the facets of the curriculum, into practicable components integrated into a synergetic whole in "right and healthy relationships". Resulting in a feasible, credible curriculum, the exercise will be accomplishment of the aim of the study reported in Chapter 5.

Expanding the literature study into specific disciplines, learning theories, educational approaches, learning styles and multiple intelligences (accommodation of learner differences), will be discussed in Chapter 4. The objectives are to identify applicable learning theories and approaches that can foster the design of a vocational curriculum for unsuccessful school leavers. Guiding this section of the study, will be typical attributes of the unsuccessful school leavers, which will be determined form the available information.

An educational approach, fundamental learning theory, educational strategy and curriculum design should culminate in a curriculum and concomitant education suitable for unsuccessful school leavers. Concluding the fundamentals of the concomitant education for the curriculum design, an appropriate fundamental learning theory and matching educational approach that will foster the design of a vocational curriculum for unsuccessful school leavers are established in Chapter 4.

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CHAPTER 4

LEARNING THEORIES, LEARNING PRINCIPLES AND EDUCATIONAL APPROACHES FOR A TRANSDISCIPLINARY VOCATIONAL SKILLS CURRICULUM FOR UNSUCCESSFUL SCHOOL LEAVERS

4.1 INTRODUCTION

In Chapter 3, applicable curriculum development and design principles for an envisaged unsuccessful school leavers' vocational-education curriculum was established. Further elaboration expands the curriculation process into aspects of the concomitant education and learning as functional attribute thereof. Identifying applicable learning theories and approaches that will foster the design of a vocational curriculum for unsuccessful school leavers are considered in this chapter.

The envisaged vocational curriculum is intended for a specific group of learners, unsuccessful school leavers, also referred to as school dropouts. Their educational needs need be considered in the curriculation processes. It is therefore necessary to improve on the "educational profile" of unsuccessful school leavers with an overview of typical attributes ascribed to them. This can provide information about the kind of education and educational strategies that will be appropriate for education aimed at improving their educational situation. Further improvement on the educational profile will be attempted with the empirical research in Chapter 5. For the review of educational models, learning theories and methods, relying on this preliminary overview, is regarded adequate.

Learning is the desired process that should be accomplished to bring about the cognitive and behavioural changes envisaged. Converting information into practicable knowledge and the features of knowledge, underlie the very essence of education: learning. Learning is fundamental to education – the focus, practice and accomplishment. Aligning educators' beliefs about teaching that should result in effective learning with the theoretical foundation established in this chapter, is a prime concern in the study (Killen, 2010:2, 3). All of the educational contributions, theories, approaches, strategies and efforts should culminate in effective learning.

Underlying effective learning is the psychological processes involved. Studying and discussing these processes is an attempt to construct a sound foundation for the curriculum and concomitant education. Formulating this fundamental theory requires selection of a learning theory conducive to the educational activities involved in the type of education envisaged. The education, embedded in the curriculum, will based on this fundamental learning theory as functional process in effective learning. Underlying the education and therefore the curriculum, it provides attributes for the formulation of premises and principles focussing and guiding educational strategies.

4.1.1 TYPICAL EDUCATIONAL ATTRIBUTES OF UNSUCCESSFUL SCHOOL LEAVERS

Establishing typical attributes ascribed to unsuccessful school leavers is attempted with an overview of the South African situation and that of some foreign countries. That can provide valuable information about an appropriate educational "model" to address their unfavourable educational situation.

4.1.1.1 Unsuccessful school leavers in South Africa

Unsuccessful school leavers' poor response to school and FET college vocational education, revealed by their poor examination results, is evidence of an unfavourable educational situation. A further concern is the fact that the majority of the school population dropped out of school implying a low school completion rate. Some typical attributes of the learners can be derived from reasons given by scholars.

Van der Berg et al (2011:13) blame the poor education results on "lenient and largely random progression in schools' local examinations," promoting incompetent learners. The quality of South African education is also questionable. Referring to "the education system generally produces outcomes that reinforce current patterns of poverty", and "low quality education as poverty trap", Van der Berg et al (2011:3) signifies the inability of the education system to provide quality education to the majority of the school population. "[L]ow-quality education up until Grade 11 can be regarded as the root cause of low attainment beyond Grade 11" (Van der Berg et al, 2011:4). Smith (2011:7) blames "the lack of foundational skills" on "poor quality education". These two factors can be related directly to poor academic proficiency of the learners.

South Africa's children perform poorly in subjects fundamental to learning. "Surveys indicate that the level of cognitive achievement of the majority of South African children is alarmingly low in key areas such as Reading, Mathematics and Science" (Van der Berg et al, 2011:3). In the Trends in International Mathematics and Science Study (TIMSS) 1999 and TIMSS 2003 Grade 8 mathematics and science achievement tests, South African children performed below world average (Department of Education, 2009:87; DHET, 2010:18, Table 60). These poor performances are confirmed by the Department of Education, FET College Examinations: Results, 2006 – 2009 and the Department of Higher Education, FET College Examinations:

Report (2009:57 – 64). These references confirm that learners lack fundamental attributes required for academic development, i.e. poor language, mathematics and science proficiency.

Poor quality education and lenient grade progression in local school examinations are primarily the cause of South Africa's school dropout. This translates into learners' lack of fundamental attributes required for academic development and progress. Other possible contributing factors are beyond the means of this study, but these considerations provide the information required for the establishment of criteria needed for the evaluation of the facets of education to be reviewed in this chapter.

4.1.1.2 Unsuccessful school leavers in Europe and Great Britain

The phenomenon of school dropout is not uniquely South African. School dropout in Europe and Great Britain is much lower than in South Africa, but certain regions experience greater problems, e.g. Catania in Italy, Peristeri in Greece and Seacroft Ward area in Leeds in the United Kingdom (Chistolini, 2008:221). The attributes of the typical unsuccessful school leaver in these countries are significantly similar to that of South Africa.

Chistolini (2008:219) mentioned the problem experienced by school dropouts as typically learning difficulties, neglect, low self-esteem and often, negative attitude. The second chance schools aim at combating unemployment, social exclusion and poverty.

Second chance schools in Europe and the United Kingdom include skills that lay the foundation for further education and development in their curricula. These skills, fundamental to education, ability to learn, mathematical skills, scientific skills and linguistic skills are prerequisites for the vocational education at offer to their unsuccessful school leavers (Chistolini, 2008:224).

The Centrum Voor Europese Studies en Opleidingen (CESO) (2000) recommends a "different teaching and counselling approach" for the education of unsuccessful school leavers. It is acknowledged that they did not respond favourably to mainstream education and should be accommodated in different curricula with a different approach and strategies.

Although the situation in South Africa differs, with respect to socioeconomic circumstances and learner needs, the countries have socioeconomic exclusion, social disorder and the fundamental right to effective education to all learners in common. These circumstances, with learner needs of paramount importance, can be addressed in a similar way as the European second chance schools with curricula and structure designed to suit the local situation.

4.1.1.3 Typical educational attributes of unsuccessful school leavers

Unsuccessful school leavers in South Africa, Europe and the United Kingdom have a number of significant educational attributes in common, which can serve as criteria to consider in an effort to establish education for unsuccessful school leavers.

They do not respond well to mainstream education, leaving them poorly prepared for further education and employment. Contributing to their low level of educational proficiency are their poor performances in the subjects fundamental to learning: language, mathematics and science.

Their inability to respond adequately to the linguistic-logic-mathematical predilection of mainstream education necessitates education with a different approach and strategies. Vocational education was instrumental in upliftment of people in the past and is currently recommended by the European Commission, CESO and the South African Department of Education (RSA, 2008:22, 23) for unsuccessful school leavers. Within the domain of vocational education unsuccessful school leavers can be accommodated, but their poor educational foundation points towards a level below NQF 2.

Considering their educational experiences reflected by the official statistics and their low level of educational proficiency, their education should be established on a sound foundation, a fundamental learning theory ensuring appropriate strategies to enable construction of an educational foundation as prerequisite for capacity building.

4.2 PSYCHOLOGICAL LEARNING THEORIES

Psychological learning theories attempt to describe the psychological processes involved in learning and often reflected in behaviour. An understanding of the psychological processes of learning is essential for presentation of and exposure to material that provides the learning content. Feldman and McPhee, (2008:18) acknowledge the importance of educators' "conceptualisation of learning" in education. Knowledge as the product of learning is the "commodity" involved in complex and integrated psychological processes. How to administer the learning material to facilitate establishment of the "commodity" and the significance thereof will be substantiated by its composition and attributes.

The psychological processes of learning are distinctly different from the learning preferences, also called learning styles, of learners (cf. 4.3.2). The notion of "how learners learn" does not distinguish between the two concepts, but they should not be confused with each other. Learning preference/style is a preferred method of how to go about learning, while psychological processes of learning are complex cognitive activities. Woolfolk (2010:121) regards "learning preferences" as "a more accurate label because most of the research describes preferences for particular learning environments".

Three major learning theories underpin the current views on learning: behaviourism, cognitivism and constructivism (Feldman and McPhee, 2008:40, 46, 53). A number of learning theories can be associated with these three schools of thought, but only a few are considered for their contributions to the development of learning theories. Structuralism, Functionalism and Gestalt theory are included because they lay foundations for progress in further development. Gestalt theory made significant contributions to constructivist and cognitive learning theories in general (Jordaan and Jordaan, 2000:302). These theories are discussed briefly to provide the motivation for selection of a fundamental learning theory with essential attributes to facilitate effective learning of unsuccessful school leavers.

4.2.1 OVERVIEW OF LEARNING THEORIES UNDERLYING THE SELECTION OF A FUNDAMENTAL LEARNING THEORY

In general, learning theories attempt to explain learning through behaviour modification and the psychological processes involved. Behaviourism focuses on explanation of learning by observation of (human) behaviour (Feldman and McPhee, 2008:40). Cognitive science, often utilising the computer metaphor, explains learning through the cognitive processes involved in learning. Social learning theory incorporates aspects of behavioural and cognitive learning, but it is not considered because its attributes to learning are covered by constructivism and later developments in psychological learning theories (Louw et al, 2008:266, 267). Constructivism is a psychological theory of how people learn and the nature of knowledge (Hein, 1991:1 of 8).

Minor differences in approach, emphasis and interpretation are of no concern to this study. The focus is on a theoretical foundation for practicable unsuccessful school leavers' education. Fundamental theories and practices that can facilitate education for their specific situation will be considered.

4.2.1.1 Behaviourism

Behaviourists believe that human behaviour can be explained without the need to contemplate internal mental states or consciousness (Louw, Edwards, Foster, Gilbert, Louw, Norton, Plug, Shuttleworth-Jordan and Spangenberg, 2008:16). ***Learning is defined as the "process or processes that are believed to underlie observable behavioural change in situations associated with practice, instruction and life experiences"*** (Jordaan and Jordaan, 2000:441). The theory does not account for other types of learning and denies the scientific value of the study of mental processes. Parents and teachers are behaviour modifiers.

Human and animal behaviour is made up of externally observable measurable activities and conduct related to environmental occurrences. Consciousness and other mental processes were considered inaccessible to scientific study and therefore could not be attributed valid research status. Stimuli on the other hand are controllable and responses objectively observable. "The content of the mind is therefore the synthesis of our experiences and little else" (Hergenhahn and Olson, 2005:60, 267).

Further contributions to behaviourism were made by other psychologists closing the gap between behaviourism and cognitivism. Some of Tolman's principles of behaviour – behaviour is purposive and behaviour is cognitive – further contributed to better understanding of learning (Lefrançois, 2000:175).

Although behaviourism as a theory of learning is not so prominent any more, it is still influential in terms of the following:

- Learning outcomes can be compared to the setting of measurable goals as explained by behaviourism
- Feedback was a concept introduced by behaviourism that is still of importance
- The sequencing of the learning process has its origins in behaviourism (Massyn, 2009:48).

Behaviourists did groundbreaking work for the development of psychology, but the persistence of cognitive psychologists laid the foundation for more balanced perspectives in the field. Behaviourists accepted that association and conditioning involve cognitive processes, but questioned the scientific validity of cognitive psychological research. They believed that internal processes cannot scientifically be studied.

Contrary to behaviourism, psychological learning theories regard learning as active information processing mental activity, constructing knowledge on a foundation of existing mental representations (Feldman and McPhee, 2008a:55). Mcleod (2007:1 of 3) states: "Cognitive Psychology revolves around the notion that if we want to know what makes people tick then the way to do it is to figure out what processes are actually going on in their minds."

4.2.1.2 Cognitive learning theories

Cognitive psychology is the study of the mental processes that people utilise to interact with their environments. These processes include how people perceive, think, learn, remember and adapt to their environments. According to Mcleod (2007:1 of 3) "[T]hey (cognitive psychologists) are interested in the variables that **mediate** between stimulus/input and response/output. Cognitive psychology assumes our behaviour is an internal process including perception, attention, language, memory and thought." Human learning is seen as complex conscious and unconscious cognitive activity processing incoming information by actively creating mental representations (Sternberg, 2003:2). Cognitive psychologists responded to behaviourism's mechanistic, reductionist research mode towards human and animal learning by incorporating purpose and consciousness in psychological research on learning (Lefrançois, 2000:171). ***Learning is defined as change in learners' symbolic mental constructions.***

Cognitive learning theory maintains that humans learn by organising learning situations and learning material perceptually and forming concepts, rules and cognitive patterns mentally. According to Feldman and McPhee (2008:46) "cognitivists use the metaphor of the human mind as an information-processing device or computer". Louw et al (2008:17) also mention the notion of cognitive scientists that the brain is an information-processing device. Cognitive, verbal, perceptual-motor and intellectual skills are learned cognitively. Cognitive learning also involves insight, the relations between concepts and recognition of gestalt (wholes) that often have to be completed mentally. Cognitive psychology on learning went through stages of development although often virtually simultaneously. Only a few are briefly discussed in the process of selecting a theory appropriate to unsuccessful school leavers' education.

4.2.1.2.1 Structuralism

Structuralists, Wilhelm Wundt and Edward Bradford Titchener inter alia, use introspection and descriptions of "raw" experiences (without "labelling" them) to study elements of thought, which constitute complex ideas combined by association (Louw et al, 2008:15). Their aim was to determine what consciousness is, describing its structure by careful observation of conscious experience. By breaking up perceptions into their constituent parts in an effort to understand the structure of the mind, they study sensory experiences through introspection – analysing their own perceptions (Sternberg, 2003:6). Objections against structuralism are the doubtful reliability of introspection and "limited questions about human nature". "They could not answer the question about conscious experience and human behaviour" (Jordaan and Jordaan, 2000:13).

4.2.1.2.2 Functionalism

Functionalists, William James and John Dewey inter alia, challenge structuralism for ignoring their approach of how behaviour and consciousness (mental activity) are related to survival. The aim of functionalism was to determine the function of consciousness and basic mental processes. Both schools of thought (structuralism and functionalism) tend to divide (break down) these mental activities into simpler, easier-to-understand ideas. Gestalt psychologists considered the elementistic approach inappropriate to study the complex interrelated behavioural and mental functionality of people (Hergenhahn and Olson, 2005:265).

Pragmatism, with its notion of what can be done with knowledge acquired, was a natural consequence of functionalism. Learners should know the practical use of what they are supposed to learn (Sternberg, 2003:7).

4.2.1.2.3 Gestalt

Although Gestalt psychology, one of the earliest forms of cognitive psychology, developed at about the same time as early behaviourism, the latter dominated psychology for some time during the first half of the twentieth century – especially in the USA. Gestalt psychologists, Max Wertheimer, Kurt Koffka and Wolfgang Köhler inter alia, believed that psychological phenomena should be studied holistically – they should not be broken down into components because the whole is more and different from the sum of the constituent parts (Sternberg, 2003:122). Humans perceive in gestalt (structured wholes). Gestalt theory also provided for the perception of form and learning by insight.

These concepts, illustrated by Sternberg (2003:125) and Gillani (2003:139), are represented by the laws of Gestalt:

- **Law of closure** refers to the tendency of people to mentally complete a perception – add missing information – of an incomplete image (Gillani, 2003:139; Sternberg, 2003:124; Louw et al, 2008:151).
- **Law of similarity** refers to the tendency to group similar items together to form a gestalt (structured whole) (Gillani, 2003:139; Sternberg, 2003:124; Louw et al, 2008:151).
- **Law of proximity** refers to the tendency to see things that are close together as belonging together (Gillani, 2003:139; Sternberg, 2003:124; Louw et al, 2008:151).
- **Law of symmetry** refers to the tendency to see bits and pieces that resembles mirror images of each other as symmetrical structures (pairs of) rather than groups of similar items (Gillani, 2003:139; Sternberg, 2003:124).
- **Law of continuity** refers to the tendency of the mind to perceive interrupted patterns as the simplest, most orderly, symmetric, and regular figures they could represent (Gillani, 2003:139; Louw et al, 2008:152).
- **Law of common fate** refers to the tendency to see elements moving in the same direction as a collective or unit (Gillani, 2003:139; Louw et al, 2008:152).

These laws refer to the feature of human perception always tending towards order, regularity, symmetry, simplicity, harmony and completeness (Gillani, 2003:138; Sternberg, 2003:124;

Louw et al, 2008:151). Humans tend to make sense of reality within the frameworks of mental representations which are complete, organised, meaningful and simple (Hergenhahn and Olson, 2005:268).

Learning involves complex cognitive processes, constructing mental representations of information perceived. Often, learning is the recognition of relationships between the perceptions instead of (only) the perceptions themselves (Snowman and McCown, 2011:366). This emphasises the importance of relationships between stimuli or elements of information. Incorporating these features in educational practice, makes sense for educators.

The concept of learning by insight in Gestalt theory is the recognition of relationship and relevance of mental representations to a problem or situation, which results in the unconscious psychological formulation of the mental construction of the solution (Lefrançois, 2000:177; Sternberg, 2003:373). Prior mental representations, relationships, relevance, association and well-organised constructs are essential for problem solving and insight. In the absence of this prior knowledge, none of these mental processes is possible. The characteristics of insightful learning are significant to education:

- "The transition from pre-solution to solution is **sudden, complete**" and an unconscious leap in thinking
- "Performance, based on a solution gained by insight, is usually **smooth and error free**"
- Solutions gained by insight is **long-lasting**
- Principles attained by insight are **easily transferred** to other situations. Consequently, relationships will get preference over associations (i.e. conditioned stimuli) – a principle called transposition. Although a new situation includes prior mental representations, the previous relationships will be determinant in the mental processes (Hergenhahn and Olson, 2005:278).
- "Often, an insight involves reconceptualising a problem of a strategy for its solution in a totally new way" (Sternberg, 2003:373).

Prior knowledge – concepts and relationships – are essential for learning in general and learning by insight. The more learning occurs the better the preconditions will be for future learning and insight – the more effectively information will be processed (coded and perceptualised) (Sternberg, 2003:375; Woolfolk, 2010:236).

The core of the legacy of gestalt learning theory for educators comprises holistic perception, complex cognitive processes and learning by insight. Humans perceive reality holistically: the whole is different and more than the sum of the constituent parts always tending towards order, regularity, symmetry, simplicity, harmony and completeness. Constituent parts are analysed afterwards and then reconstructed. The conscious and unconscious cognitive processes include recognition, relevance, relationships (links), organisation and construction of meaning. Learning by insight involves similar cognitive processes, relying on existing mental representations, constructing new structures with sudden breakthrough into the consciousness mind, having a complete solution to the problem/challenge. Holism, an evolutionary phenomenon of reality, also features in philosophy (Smuts, 1926:86–117).

4.2.1.2.4 Constructivism

Constructivist learning is the active conscious and unconscious mental involvement of the individual, organising incoming information and finding relationships with existing mental representations in the process of constructing new mental structures (Killen, 2010:7; Snowman and McCown, 2011:38, 245). Constructivism is corollary to gestalt theory.

The main assumption of constructivism is that each individual has to construct his/her own mental representations by interpreting information perceived from the learner's own personal observation of reality (Woolfolk, 2010:341). Nobody else can do it for a perceiver. Learning is an active process: the learner is central in the learning process which is subjective and based on the prior learning experiences of the learner as well as the context or situation where the learning takes place (Snowman and McCown, 2011:322). The role of instruction is to support knowledge construction (as opposed to teaching already processed information) and the emphasis is on discovery of embedded meaning.

A number of psychologists, Jean Piaget, Jerome Bruner, Herman von Helmholtz, Richard Gregory, Irvin Rock, Lev Semyonovich Vygotsky (socio-constructivism), inter alia, contributed to the theory of constructivism (Feldman and McPhee, 2008:55; Woolfolk, 2010:310).

Learning is an active, constructive process of building mental structures (knowledge) through progressive conceptualisation (internalisation) of actions where actions are not restricted to psychomotor activities. The learner is the information constructor. People actively construct their own subjective representation of objective reality. New information is linked to prior knowledge, thus mental representations are subjectively being assembled from new information and previously constructed concepts and links. Information is observed, differentiated, interpreted, integrated, synthesised, organised and generalised into new mental representations. Learning is **not** a straightforward process of feeding learners information, which they receive (absorb), encode (understand), memorise (store), retrieve (recall) and apply as acquired knowledge. This misinterpretation of the notion reflects only on the lowest levels of Bloom's taxonomy of learning. "Constructivism is a model of the learner as a builder of knowledge" (Lefrançois, 2000:336). Knowledge includes reflections on own responses to perceptions and concepts.

"Reality is relative to the way in which it is observed and there is not just one true reality," is an underlying principle of constructivism (Jordaan and Jordaan, 2000:63). Mental representations are subjective because they are constructed from incoming stimuli, existing mental structures, notions of relevance and ways in which they are related or assimilated. Much of the processing is unconsciously executed. The work of Piaget is important, as the very basics of the theory of learning, fundamental to this envisaged curriculum, will be based on his theory.

The two major principles of Piaget's constructivism are adaptation that includes assimilation and accommodation of external events with existing mental structures referenced to the latter and organisation as a nature of the mind, rearranging new perceptions into mental structures in complex and integrated ways (Bhattacharya and Han, 2009). Schemes of assimilation tend to feed themselves by incorporating compatible outside elements, causing the alteration of the entire scheme of assimilation (Piaget, 1975:6–10). "The conceptual structures that we consider to be 'knowledge' are the products of active knowers who shape their thinking to fit the constraints they experience" (Von Glasersfeld, 1997:5).

Cognitive adaptation includes the generation of mental structures, the formulation of mind maps and creation of order and harmony with perceptions of the environment or situation. Adaptation is also the result of clashes of mental presentations with constraints presented by reality, and leading to rearrangement and reorganisation of schemata. This implies the generation of knowledge that resembles reality more and more closely (Von Glasersfeld, 1982:3; Snowman and McCown, 2011:37).

Schemata are mental representations (constructions) of the environment (mind maps), procedures in psychomotor activities and/or sets of associated concepts (perceptions, ideas). Cognitive development involves the creation of new schemata by assimilating new information and existing schemes; reorganising and rearranging existing schemes into new configurations to adapt to new situations (Woolfolk, 2010:248). "On the practical level, it is a matter of devising schemes of action that circumvent the obstacles and perturbations the environment places in the organisms path" (Von Glasersfeld, 1997:5).

Equilibration is the impetus to create a state of equilibrium between the environment and mental representations – to balance external events with internal schemata – by composing new mental structures or adapting existing ones. Equilibrium is reached with assimilation and accommodation when mental representations fit external reality. Equilibration as mental organisation, rearranging, restructuring and integration of schemata facilitates cognitive development and effective thought processes (Hergenhahn and Olson, 2005:298; Woolfolk, 2010:33; Snowman and McCown, 2011:37).

Social interaction is a form of adaptation to the environment and presents the opportunity to evaluate concepts and schemata for closer resemblance of true reality (Snowman and McCown, 2011:37). "Piaget was the first to methodically employ this notion in psychology and proceed on the assumption that our ideas are individual creations. The mutual compatibility of these creations with those of others has to be achieved by social interaction" (Von Glasersfeld, 1997:3). Learners can improve their mental representations of reality through cooperative learning. Interactive explanations, challenging questions, peer evaluation and different perspectives can promote effective learning (Snowman and McCown, 2011:323). Borchert, Brandt, Hokanson, Slator, Vender and Gutierrez (2010:319) regard social interaction a significant improvement to "rote memorisation" in learning and a "key element" in evaluation of learning processes.

Learning is not entirely a steady process of acquiring knowledge. Mental representations are organised, modified and generalised to other areas, enabling application beyond the original situation. Additions to these mental structures cause more organisation, modification and generalisation, and new structures are unconsciously created in increasing complexity. This involves recognition of relationships and relevance and establishment of new links. When confronted with a problem/situation these structures form bases for rearrangement of knowledge which can produce, primarily unconsciously, a complete solution (gestalt) to the initial challenge. This is unconscious invention of a new scheme which satisfies the need inherent in the situation. Mental involvement, active engagement with the situation/problem and prior knowledge are essential prerequisites for the mental process. This process is a rapid leap to higher cognitive activity: insight (Baumert, Krauss, Kunter and Brunner, 2003:2). Compare Bloom's revised taxonomy of learning levels of analyses and synthesise (cf. 4.3.1).

Gestalt and constructivist theories laid the foundations for further development in psychological learning theories. Psychological learning theories attempt to explain human learning by the mental processes enabling human actions and behaviour. Cognitive psychologists try to understand human interaction with the environment and the cognitive processes involved.

Within the field of cognitive learning theories, constructivism and further developments in this specific paradigm, provide the fundamentals required for the establishment of effective learning in the envisaged curriculum and concomitant education for unsuccessful school leavers. Constructivism and further elaboration on the initial theory make provision for the initiation of learning, learners' role in the learning process, how learners learn (psychological processes), prerequisites for learning, perceptual-motor learning, perceptual-motor and cognitive learning relationships and essentials for the establishment of effective learning in learning opportunities. Further elaboration on these psychological processes is done in an attempt to establish a fundamental learning theory for the envisaged curriculum and concomitant education.

4.2.2 FUNDAMENTAL LEARNING THEORY BASED ON CONSTRUCTIVISM AND FURTHER DEVELOPMENTS

As discussed above, cognition is the mental processes involved in observation, learning, memorisation and thought. Interaction with the environment – including people – understanding, appreciation and behaviour are founded on mental processes. These processes are significant to educators in pursuit of continuous improvement of the outcomes of education. They provide the answers to the question: How do learners learn? in terms of the mental processes involved. This notion excludes learning preferences, also called learning styles, of learners.

Cognitive psychology is a branch of psychology involved in examining internal mental processes utilised for learning, language, thought, memory, problem solving and behaviour in general (Woolfolk, 2010:237). Cognitive psychologists accept the scientific method as valid and reject introspection. They acknowledge the existence of internal mental states such as belief, desire and motivation. Cognitive psychology developed as a logical consequence of the progress made in psychological research (Sternberg, 2003:2, 109; Louw et al, 2008:278).

Human cognition, behaviour and psychomotor activities have a biological base, with the central nervous system being the control centre of interaction with the environment and thought (Jordaan and Jordaan, 2000:83). Bringing the physique into the equation adds to the complexity and intricacy – adding health, emotions and physical disposition to already complicated cognitive and behavioural processes. Educators should be aware of the influences of these processes and contributing factors in regard to education. Essentially, education necessitates comprehension of learning processes as prerequisite for teaching. Teaching is inconceivable without a thorough knowledge of learning.

Educational principles and premises derived from the cognitive processes involved in learning are fundamental to teaching strategies and learning opportunities. The experiences (learning opportunities) to which learners will be exposed should harmonise with the natural features of perception and conceptualisation. Individual differences cannot be ignored, but should be a continuing consideration throughout all the educational processes of a curriculum. The theoretical consideration is divided into two facets, constructs and processes.

4.2.2.1 Learning constructs in fundamental psychological learning theories

The intention with the consideration of learning theories is to establish a fundamental theory as foundation for unsuccessful school leavers' education. Unsuccessful school leavers need to develop their ability to learn effectively because their preceding education failed them in this regard. Scrupulous distinction between the variations of constructivist learning theories is of no concern in this study, but a sound foundation for unsuccessful school leavers' education. Learning needs to be founded on an appropriate fundamental theory to afford learners the opportunity to establish ability and strategies to learn effectively.

4.2.2.1.1 Concepts

Concepts (general abstract ideas) are the mental representations (ideas, notions) of entities collectively established according to their qualities, features, state of mind of the perceiver and interaction amongst people (*intersubjectivity*) (Louw et al, 2008:384). They find a commonality in language and can focus the minds of various people on the same entity when required. "Concepts are mind-dependent, but common to many minds" (Lacey, 2007:54). "The fundamental unit of symbolic knowledge is the concept" (Jordaan and Jordaan, 2000:353). They are categories of related things (objects), situations, phenomena and conditions. Being fundamental in human cognition, they are elements of human thought, imagination and reasoning.

Concept formation relies on the qualities assigned to objects/notions, categorisation according to these qualities and mentally assembling the most typical examples of these objects/notions (Sternberg, 2003:256). The properties an object/notion possesses qualifies it as belonging to a specific group hence concept categorisation and identification (Lefrançois, 2000:199). Incoming information is organised in terms of pre-existing categories and new concepts are constructed by assimilating new information and existing mental representations. Interaction with the environment and people institutes concepts. Concepts can be acquired through direct teaching-learning (intervention of an educator/parent) or through personal experience.

The attributes according to which concepts are categorised or formed are their denotative qualities (Louw et al, 2008:384). Interactions and experiences with concepts establish connotative qualities – emotional associations which may be negative, neutral or positive. These connotative qualities will affect the predisposition, the feelings and responses of people.

In education many new concepts have to be constructed by the learners. Being at the foundation of knowledge acquisition, concepts deserve serious deliberation during planning and preparation of learning opportunities. Possible connotative qualities should not be overlooked in the preparation process and the negatives eliminated.

Concepts help to integrate apparently unrelated observations and phenomena into viable theories and hypotheses, the basic ingredients of science and education. Formation of concepts in unsuccessful school leavers' education can be enhanced by the constructive principles of significance, relevance, categorisation and assimilation. Featuring in identification, construction, function and operation of objects, signifying clear concepts are fundamental to the unsuccessful school leavers' curriculum. Observing and handling of objects without elaboration cannot present sufficient information for knowledge construction significant to unsuccessful school leavers' educational development. Procedures (handling) have a cognitive base constituting declarative and procedural knowledge (cf. 4.2.3).

It can be concluded that concepts, their attributes and facilitation of generalisation promote behaviour and interaction with the environment. Combining concepts into propositions (units of thought) facilitates the development of complex thought patterns. Further combinations, e.g. mental scripts, enable even more complex thought.

4.2.2.1.2 Propositions

A proposition is the smallest unit of knowledge (unit of thought) which can exist as a statement (Louw and Edwards, 1993:424). A cluster of concepts forms a proposition, enabling more complex thought (Jordaan and Jordaan, 2000:359). Propositions can also reveal the relationships between concepts and their attributes, and between concepts constituting a proposition. Sternberg (2003:219) posits, "A proposition is the meaning underlying a particular relationship among concepts." From Louw and Edwards (1993:424) it can be concluded that a proposition comprises concepts, which is contradicted by Sternberg, (2003:220) stating that "[t]he key idea is that the proposition form of mental representation is neither in words nor in images but rather in an abstract form representing the underlying meanings of knowledge." Louw and Edwards (1993:424), however mentioned that a proposition often identifies the relationship between a concept (e.g. cat) and a feature of that concept (fur). Propositions can therefore be regarded as mental representations assigning meaning to compositions of concepts, their attributes and relationships constituting human thought.

In knowledge construction, meaning, relationships (associations), links, abstract notions and contexts are equally important because they are "equal partners" in human thought. Together with concepts and images they develop into mental scripts/schemas.

4.2.2.1.3 Mental scripts (schemas)

Scripts are patterns of behaviour which involve sequences of actions or conduct, enabling people to repeat composite tasks and interpret situations and information. Woolfolk (2010:248) describes schemas as "abstract knowledge structures that organise vast amounts of information". Interpretation is done by putting new events and information in the frames of established scripts. In unfamiliar situations, mental scripts can provide the context for analysis and construction of a pattern of behaviour for active involvement (Jordaan and Jordaan, 2000:509). Experience, and consequently repetition, leads to elaboration and modification of approach, procedure, sequence – modifying the entire mental script (Louw et al, 2008:389). Relevant concepts and appropriate procedures are stored in memory as a mental script or schema for future utilisation in similar situations (Snowman and McCown, 2011:255).

Mental scripts are activated by the monitoring process as a result of evoked anticipation and hypothesis formulation in preparation of appropriate behaviour. Various mental processes involved are unconsciously executed as described earlier. Through experience and repetition some psychomotor activities become automated like the procedures of motorcar driving (procedural knowledge unconsciously applied).

4.2.2.1.4 Images

Images are visual mental representations of physical objects. Woolfolk (2010:246) referred to them as mental representations (*recreations from memory*) of "physical attributes and spatial structures of information". They can be manipulated, reorganised and categorised to facilitate problem solving, memorisation and association (Jordaan and Jordaan, 2000:350). Imaging often consists of manipulated and/or integrated images, which may differ from the original (Louw and Edwards, 1993:242).

Human cognition is the delineation of reality in mental constructs consisting of three basic types of symbolic representations: images, concepts and language. Images, like other mental representations, are functionally equivalent to the objects they represent (Sternberg, 2003:225). They are not true replicas (photocopies) of the real objects due to the mental processes involved. An object can be mentally represented as an image and a concept simultaneously, e.g. the concept *cat* can be a *word* and an *image* stored in memory.

Snowman and McCown (2011:253) consider the inclusion of pictures a significant improver of comprehension. Besides the scientific proof mentioned, it can be explained by means of the psychological processes of learning. Pictures, the sources of mental images, add significance to the text, provide more links and enhance the structure of the mental representations constructed. Recall of the knowledge will also be improved. The theory of dual coding of Allan Paivio that concrete material is remembered better than abstract words because they can be encoded as images and verbal labels, confirms the explanation (Louw et al, 2008:301; Woolfolk, 2010:246; Snowman and McCown, 2011:254).

Mental representations are significantly enhanced by language.

4.2.2.1.5 Language

Language is one of the most powerful instruments in human thought even though not essential (Louw and Edwards, 1993:425). Humans can think, using the other tools (images, concepts) at their disposal, but language assigns richness. Language can shape thought by facilitating manipulation of concepts and structuring of knowledge with its rich variety of descriptors and designators (Jordaan and Jordaan, 2000:363). Speakers of languages other than the medium of instruction may not have full privilege of the mentioned conceptualisation tools at the disposal of other learners. Poor language proficiency is one of the major problem aspects affecting unsuccessful school leavers in education. Their low level of language proficiency hampers communication, learning and expression (Van der Berg et al, 2011:14).

Conceptual proficiency does not rely on language proficiency (Jordaan and Jordaan, 2000:363). Education for unsuccessful school leavers should capitalise on this feature by incorporating more images, objects, handling of objects and perceptual-motor development into the curriculum. However, communication is negatively influenced by language deficiency, resulting in a need for special education. Practicum-based education provides the opportunity of learning aided by demonstration/observation, physical handling and procedures, but needs to be complemented by communication and comprehensive declarative knowledge construction. Although valuable initiation, demonstration and observation have limited capacity in declarative knowledge development. Non-English-speaking learners may have difficulty in understanding and expressing themselves, causing serious teaching-learning (learning opportunity) problems in predominantly English classes.

Verbal communication, essential in education, requires certain basic skills to be effective. The sounds (signals) produced should have the same meaning to the participators. Pronunciation of words – the sounds – is very important especially in a multi-culture class. One missing link (misunderstood word) can ruin the intention of the communication. Semantics of the language, with reference to specific relationships in expressions, denotes meaning in the context of the sentence. Words as symbols of objects, ideas and actions should convey the same "message" to the participants. Sentence structure, syntax and expression techniques are essential for language proficiency. Woolfolk (2010:55) emphasises the importance of direct language to avoid misinterpretation. Passive voice may be confusing for other language speakers because the order of words is changed and a different rule applies. Expression modes between languages differ – even more so between languages from different language-family groups, e.g. European language and an African language. Ways of conveying a message effectively, with all the connotations attached, rely on comprehension of these rules and modes. This knowledge includes the basic rules of the specific language (Jordaan and Jordaan, 2000:360).

Thought is significantly enriched by language, adding its variety of attributes to the mental representations of people. Pondering a situation or considering solutions to a problem is thought in action promoted by language. Language complements perception, conceptualisation and manipulation in mental processes. For normal people language and concepts are virtually opposite sides of the same coin, interrelated and supplementary.

Language, **images** and **concepts** constitute the symbol systems and thinking apparatus of humans (Jordaan and Jordaan, 2000:349). Concepts, images, propositions, "psychic models", mental texts and words are the elements of thought (Louw and Edwards, 1993:419). Elaboration on the psychological theory of learning is engendered with a discussion of the mental processes in constructivist psychological learning theory.

4.2.2.2 Processes in constructivist psychological learning theory

Learning involves comprehensive and complex mental processes whereby information is converted into mental representations and stored for later retrieval and use. Effective learning, although a personal function, relies on facilitation of these processes rendering a fundamental learning theory imperative in education. Equipped with this knowledge educators have a foundation for effective facilitation of effective unsuccessful school leavers' learning and development of learning strategies.

4.2.2.2.1 Monitoring

The human brain functions on conscious and subconscious levels (Jordaan and Jordaan, 2000:291). Monitoring is the unconscious rapid processing of information to determine significance, increase flow of stimuli, create anticipation and form sensory memory of the stimuli in preparation for effective perception and appropriate behaviour "Feeding forward" stimulus traces (bio-electrochemical pulses) to the relevant brain areas, and recalling previous experiences related to new stimuli, happens on the subconscious level. Woolfolk (2010:237) describes sensory memory as temporary storage for information "so that this initial processing can take place", but calling the "initial processing" sensory memory. Jordaan and Jordaan (2000:295) distinguish sensory memory (stimulus traces) as part of monitoring. Snowman and McCown (2011:247) describe the initial processes of perception as sensory register and control processes. According to Jordaan and Jordaan (2000:293) unconscious comparison of stimulus traces with memory content requires answers to the following questions:

- "What has happened out there?"
- "Has it ever happened before?"
- "Were the effects of the event pleasant or unpleasant?"
- "Is the event out there sufficiently important to warrant attention?"
- "How did the person respond to the related event previously and what should the response be now" (Jordaan and Jordaan, 2000:293).

These processes handle more information than can be converted into useful perceptions and mental representations (Woolfolk, 2010:237). The brain has limited capacity for processing information into conscious experience. Large volumes of stimuli from the receptors (coded bio-electrochemical pulses) are organised and differentiate between relevant and irrelevant, making the significant applicable information available for further processing.

Relevant information is the information that has significance for the perceiver in terms of previously constructed mental representations and links. The lifespan of sensory memory is about one second (Jordaan and Jordaan, 2000:300; Woolfolk, 2010:237), which could lead to a slowing down of information flow. This "bottleneck" is a feature to be considered when exposing learners to new information/events (cf. Gestalt theory, 4.2.1.2.3). Known shapes, words, parts, objects and links will take preference over unknown stimuli (information) (Jordaan and Jordaan, 2000:302; Woolfolk, 2010:238). In the mental selection and organisation of stimulus traces irrelevant stimuli and information insignificant to the perceiver are unlikely be processed into perceptions and experience.

Sensory memory is not an exact copy of the stimuli collected by (projected onto) the receptors. Even at this early stage of cognitive processing, the influences of existing mental representations are present. Incoming stimuli are unconsciously compared to related memory content, organised and relevant information selected for further processing. Snowman and McCown (2011:248) mentioned the influence of existing mental representations ("prior knowledge") on perception and that the lack of "relevant prior knowledge" will hamper "recognition and meaningful processing".

Perceptions are the products of stimuli-memory assimilation processes and state of mind. Interpretation of reality is a process of assigning meaning to incoming stimuli within the existing mental frames, constructing new mental representations and frames of reference. These representations are manipulated, reorganised and integrated into, sometimes, completely new constructs (Sternberg, 2003:138). Perception of reality is every person's own mental representation of what is perceived as reality – it is a product of the mind, not a photocopy of stimuli impinging upon the receptors. The perceptual process is highly subjective due to subjective psychological disposition – state of mind, experience (mental representations) and frame of reference (Jordaan and Jordaan, 2000:346; Woolfolk, 2010:239; Snowman and McCown, 2011:248).

Intersubjectivity is a kind of consensus amongst people that determines the criteria of perceptions and behaviour in general. These criteria determine what meaning will be assigned to the information (perception). Conciliation is possible because perceptions of reality of different people correspond sufficiently to accommodate communication and consensus about reality. Through communication and interaction, people make sense of the world in ways that make sense to others, developing intersubjectivity and contextualising interpretation (Jordaan and Jordaan, 2000:344). ***This emphasises the importance of group work, group discussions and educational interaction.***

4.2.2.2.2 Perception

"Perception refers to the way in which people process, interpret or assign meaning to the information they receive via their sensory systems" (Jordaan and Jordaan, 2000:285). It is however, not straightforward "absorption", encoding and accumulation of information resulting in the ability to respond to environmental occurrences. Neither is it only interaction with the environment. Learning is not a situation of *"topping up vessels" (brains)* with knowledge, in order to enhance the performance of learners (Feldman and McPhee, 2008:53). Woolfolk (2010:238) describes perception as "the process of detecting a stimulus and assign meaning to it". Meaning is constructed from the bio-electrochemical pulses provided by the sensory organs and existing mental representations. What each individual perceives as reality is the product of his/her sensory pulses, existing mental representations and the mental processes constructing his/her version of reality (Louw and Edwards, 1993:120; Sternberg, 2003:109). Various factors, important to educators, influence each of these facets of human cognition.

4.2.2.2.2.1 Attributes that influence perception

Perception is not a process of delivery and reception. Active involvement and receptiveness of the perceiver are preconditions denoting the following factors derived from the previous discussions of cognition:

- Purpose denotes the significance of the information to the perceiver – answers *"why?"*
- The level of arousal determines the state of initial attention – readiness.
- Active involvement – participation of the perceiver is essential for effective perception.
- Humans construct their own mental representations of reality. "Reality" is relative to human cognition.
- Perception comprises complex interrelated processes.
- Cognition includes unconscious mental activities.
- Perception and mental representations are subjective – a product of stimuli, existing mental representations, frames of reference, state of mind (emotional state) and mental processes (Sternberg, 2003:109).

These factors are essential considerations in learning opportunity design and presentation. If any of these are negated, the learning opportunity is prone to failure.

4.2.2.2.2.2 Conditions necessary for perception

Perception and conceptualisation are not inevitable outcomes of exposure to stimuli. Purposive mental activities are dependent on dynamic stimuli, functional receptors and nervous systems. Only some of the attributes of these systems can be externally manipulated. The following features need to be functional to facilitate perception (Jordaan and Jordaan, 2000:285–291):

- The various sensory systems must function normally (Jordaan and Jordaan, 2000:285).
- These sensory systems have to be exposed to basic sensory stimulation – preferably as many as possible (multi-sensory perception) (Jordaan and Jordaan, 2000:285).
- The arousal level should make the individual receptive to the information to be perceived (Hergenhahn and Olson, 2005:380; Woolfolk, 2010:239).
- Effective perception depends on variation of basic sensory stimulation in terms of purely physiological conditions and psychological meaningfulness (Jordaan and Jordaan, 2000:286). The physiology of the eye makes provision to avoid adaptation when concentrating on (fixedly staring at) an object – involuntary vibrations causing stimulus variation (Jordaan and Jordaan, 2000:244). Dynamic stimulation is more effective than static displays.
- The awareness threshold must be exceeded for perception to take effect. Incoming stimuli are first detected, then the detection threshold exceeded, followed by the recognition threshold, which triggers the processing of the stimuli into meaningful conscious experience. The intensity, duration, magnitude, complexity and proximity of the incoming

stimuli influence perception. Together with the individual's subjective involvement in the stimuli, they control perception (Jordaan and Jordaan, 2000:288).

- Predisposition of the learner – receptiveness is also an important consideration in mind preparation (compare Thorndike's Law of Readiness, 5.7.2.4) (Jordaan and Jordaan, 2000:289).
- Perceptual defence raises the recognition threshold to avoid or block threatening stimuli resulting in distortion or absence of perception – to avoid recognition of threatening stimuli, the tension and anxiety (discomfort) they cause (Jordaan and Jordaan, 2000:289).
- Perceptual vigilance is a low recognition threshold, being very sensitive to threatening stimuli resulting in easy recognition and adaptation/reaction to it. Deplorable and offensive behaviour, language and tone of voice are destructive stimuli in learning opportunities, destroying the potential of normal perception and learning (Jordaan and Jordaan, 2000:289).

Educators should be sensitive for threatening stimuli, avoiding it to enhance perception and eventually, learning.

These premises and conditions are essential considerations for educators to avoid education becoming a "teaching affair." In planning and presenting learning opportunities the features of learning and education should be fundamental, but perception is not the only facet of this reality. Further cognitive processes take education to its full consequence of constructing mental representations in an effort to reach equilibrium with the environment.

4.2.2.2.3 Perceptual organisation

Perceptual organisation is the spontaneous process of differentiating observed reality into relevant and irrelevant information at low levels of awareness. The process is founded on interaction amongst stimulus attributes, nerve system characteristics and existing mental representations, which include personal frames of reference (Jordaan and Jordaan, 2000:302; Woolfolk, 2010:238). Perceptual organisation ascribes meaning to new and unfamiliar information – identification and recognition.

Interacting with the environment, the sensory systems are bombarded with enormous volumes of stimuli, but due to perceptual organisation and subconscious primary monitoring, familiar or close-to-familiar information will have precedence and be converted into perception. Other scenarios may have different preferences as indicated by the Gestalt Laws and the grouping principles. They give clear guidance for teaching-learning situations in respect to presentation, demonstration and factors hampering attention (Lefrançois, 2000:180).

4.2.2.2.4 Information selection and organisation

Clear and meaningful perception is possible because of information selection and organisation in the mind of the perceiver (Jordaan and Jordaan, 2000:290, 302). Although information is selected and organised according to stimulus attributes, functional characteristics of the individual's nerve system, experience and frames of reference, educators can enhance the process (Woolfolk, 2010:239).

Organising information (stimuli) in terms of relevance, rank, logical order, intensity and complexity before exposing the learners (perceivers) to it, is a good teaching technique. Snowman and McCown (2011:246) regard information processing important because it affects learning in terms of when, how much and how well learning is achieved. Relevant stimuli (information) will get precedence over irrelevant stimuli in the mental processes. Stimuli (information) are identified in terms of existing mental representations. Relevance refers to the significance of the information to the perceiver (learner) in terms of relationships to knowledge and frames of reference.

Perception is no guarantee that the intended information was conveyed undistorted – sensed, encoded, identified, categorised, related, integrated and converted into new mental representations. Knowledge construction depends, *inter alia,* upon the information responsible for the stimuli and the existing mental representation of the perceiver (Snowman and McCown, 2011:246). A person's awareness of stimuli depends on:

- the intensity, duration, magnitude, distance and complexity of the stimulus;
- subjective involvement of the person in what is perceived – predisposition (particularly important in classroom situations). The prime determinant of predisposition is prior (internalised) knowledge, which is essential for association and assimilation. Stimuli should not compete with the thoughts of the learner. It should complement the mindset – the mind should be prepared and receptive to the new information;
- stimuli offered should not "compete" with distracting input, e.g. educator (unconscious), disruptive behaviour, outside noise (Jordaan and Jordaan, 2000:289). Learners may be more involved with distracting stimuli considering the physiological attribute that movement catches attention and psychological attributes, variation and attention. NB. In detection of stimuli, movement gets precedence.

These attributes of (incoming) information are important considerations in education because they can tip the scale in favour or against perception. Without perception, no learning can be accomplished. Learning is accomplished when the knowledge is constructed into mental representations in long-term memory (LTM). This process, conceptualisation, concludes the mental processes starting with detection of stimuli and the monitoring process. The discussion of these psychological processes is continued it the memory section of this chapter (cf. 4.2.2.2.8). Compare sensory memory, short-term memory and long-term memory with monitoring perception and conceptualisation.

4.2.2.2.5 Conceptualisation

Conceptualisation is the construction of concepts as mental representations of reality. Stimuli are recognised, identified, related and assimilated with existing mental representations to produce new mental constructs as bases of thought and behaviour. With or without incoming stimuli humans form symbolic representations in their minds. These representations are manipulated, reorganised and integrated into, sometimes, completely new constructs (Sternberg, 2003:138).

4.2.2.2.5.1 Conceptualisation processes

New information is given meaning by comparing and relating it to previously formed mental representations. Recognition and identification is done on the basis of similarity or patterns of close resemblance. Generalising incoming information allows for recognition of unfamiliar perceptions to be categorised into existing mental structures and assigning meaning (conceptual categorisation). Prior knowledge provides a basis for generalisation and categorisation of new or unfamiliar stimuli (Woolfolk, 2010:238). "Concept formation, together with the categorisation of incoming information on the basis of previously formed concepts, drastically reduces the amount of information that needs to be processed and interpreted in a particular process" (Jordaan and Jordaan, 2000:322).

4.2.2.2.5.2 Conceptualisation theories

Different theories were formulated for recognition of incoming stimuli in terms of existing mental representations. They are attempts to substantiate generalisation, identification and categorisation of new information (perceptions).

The **template theory** posits that the brain stores stencils of every visual observation made. Comparing new information with the stencils/templates until a match is found, allows categorisation and identification in terms of attributes (Sternberg, 2003:129). Storing an infinitive number of templates – even different positions of the same object – is very uneconomical (Jordaan and Jordaan, 2000:320).

Prototypes stored in long-term memory are "the best representatives" of their categories

(Woolfolk, 2010:247). Storing prototypes of visual observations, as suggested by the **prototype theory**, allows for recognition in terms of typical representative features of closely related objects. Minor differences are ignored, reducing the number of prototypes stored. New information is recognised, identified and categorised on these representative features of the prototype (Sternberg, 2003:129–131).

The **feature detection theory** posits that stimulus patterns are arrangements of certain elementary, distinctive features (Jordaan and Jordaan, 2000:321). Recognition, generalisation and categorisation are done by detecting these features, identifying the new information and assigning meaning to it (Sternberg, 2003:131).

Assimilation of the last two theories complements Gestalt theories. Humans perceive in gestalt, order, regularity, symmetry, simplicity and harmony. The whole, pattern or prototype, signifying the mentioned qualities, gets precedence over the detail and features in recognition. Relativity, relationships, links, spatial organisation and mental manipulation of images are generic mental abilities that can be attributed to a variety of concepts, models, patterns, schemas and frames. In agreement with the feature detection theory it is not necessary to store images or information in exact replication of environmental reality.

Conceptualisation does not end with mental categorisation. New concepts are constructed from significant new information and existing mental representations through cognitive processes. Recognition and categorisation are only part of complex processes. Recognised stimuli may elicit expectations associated with conceptual categories based on previous experiences. These anticipations are at a higher level of awareness than those of the monitoring function of the brain (Jordaan and Jordaan, 2000:322). In anticipation of subsequent continuation of the perceptual situation, hypotheses are postulated.

Perceptual hypotheses help to focus attention on the relevant information of the perceptual situation (Jordaan and Jordaan, 2000:322). Relevance is assigned by the existing mental representations, making it an individual validation. Irrelevant information can be disregarded, thereby simplifying the stimulus situation. Further processing is imminent considering the rudimentary state of the conceptual situation. Anticipation and perceptual hypotheses prepare humans for reaction to the situation without conscious planning, reducing reaction time. Virtually instantaneous motor reactions enable humans to perform remarkable psychomotor activities, e.g. musicians and sportsmen. Experience enhances the creation of perceptual hypotheses and exercise perfects psychomotor activities (Jordaan and Jordaan, 2000:322–323). ***Perceptual hypothesis justifies the notion of mind preparation in learning opportunities.***

4.2.2.2.6 Imaging

Imaging is the construction of mental representations of physical objects observed. They are the prime components of mental maps and mental manipulation in humans' interaction with their environments. Imaging can be distinguished from imagination because it focuses on mind representations of physical objects (and mental maps) while imagination covers the whole spectrum of mental representations.

Humans can recall images of actual objects in the absences of these objects. Picturing, mental manipulation (rotating) of images and visualisation enable people to imagine prospective psychomotor activities in their planning of the execution virtually like a video clip. ***Simultaneous construction of images and concepts is a positive attribute in unsuccessful school leavers' practicum-based education, which can improve learning through integration of visual and abstract material*** (Louw et al, 2008:301).

Cohen et al (1996), reported by Sternberg (2003:229), "found that the same brain areas involved in perception are also involved in mental-rotation tasks." Sternberg (2003:229) continues: "Thus, not only are imagery and perception found to be functionally equivalent in psychological studies, but neuropsychological techniques verify the equivalence by demonstrating overlapping brain activity as well."

Educators should be aware of mental map (image) distortions that occur due to propositional knowledge preferences, clustering similar "landmarks" and segregating dissimilar ones (Sternberg, 2003:249). Preference is given to regular forms and shapes, distorting (changing) correct versions into popular, more familiar information. This may be particularly potent when learners are expected to rely on imaginary maps, shapes and representations in conceptualisation and execution of tasks.

The contributions of images and imaging to learning should be fully integrated into unsuccessful school leavers' education. It should be standard practice owing the arrangement practicum-based presentations – active hands-on experiences of the learners in vocational education.

4.2.2.2.7 Spatial organisation

Spatial organisation is the multi-sensory ability to determine the position of objects in space and their relationships to the environment (Louw and Edwards, 1993:147; Sternberg, 2003:241; Louw et al, 2008:390). A three-dimensional experience is made possible by various brain functions processing a mental picture from the stimuli collected by the sense organs and memory content. "Spatial organisation is based on functional attributes of the nerve system and past experience" (Jordaan and Jordaan, 2000:306).

The brain has the ability to arrange a three-dimensional picture from the bio-electrochemical pulses received from a two-dimensional retina of the eye. Distance observation with eyes and ears relies on the slight differences in the stimuli reaching each one of the pairs of organs. The image reaching the left eye differs minutely from the image reaching the right eye. The sound reaching the one ear a little before reaching the other ear, except when directly facing the source with perfectly identical distances, give a sense of direction and distance.

Objects have a relative size, sound has pitch and frequency, and colour type has intensity stored in memory. An object further away appears to be smaller, sound and colour less intense and less defined. Although its actual size remains the same, the relative size of an object in the greater spectrum of the environment is smaller and it is perceived as being further away. One eye (monocular) distance observation is made possible by the brain detecting the variation in the shape of the eye lens and head movement. The size of an object's image on the retina compared to images stored in memory gives another cue of distance (Jordaan and Jordaan, 2000:306-311).

Three-dimensional observation of pictures and drawings on two-dimensional surfaces is possible because of mental representations/mind-pictures (past experiences) constructed from observations made. Features and experiences from spatial organisation are the basics employed to perceive pictures and drawings as three-dimensional. Three-dimensional observation relies on relative size, object attributes creating the impression of distance/depth and previous experiences. However, imaging cannot be seen in isolation. Compare mental scripts (schemas) above (Sternberg, 2003:263, 264).

In an educational scenario, much of the information from which the learners are supposed to extract learning content is through visual learning material – visual observation. In practicum-based education, addition of visual observation is of paramount importance because declarative and procedural knowledge need to be constructed simultaneously (Sternberg, 2003:268, 269). Educators will demonstrate and learners will experience hands-on practica.

4.2.2.2.8 Memorisation

Information processing occurs in stages (or steps). Snowman and McCown (2011:246) mention three memory stages, sensory, short term and long-term memory, but the whole process, from detection to long-term memory storage, involves more than memory procedures, e.g. monitoring, perception and conceptualisation. They mention the finding that the brain becomes more efficient at information processing as humans develop higher levels of proficiency. Monitoring, represents the "awareness" of perception feeding forward significant stimuli into short-term memory and includes the first memory stage, sensory memory.

Memory is the mental capacity to encode, store and retrieve information. The mental processes involved are discussed in 4.3.2. Information is stored for referencing, orientation and later use. New information would be meaningless without memory "content" as reference. Three types of memory are distinguished: sensory, short-term (STM) and long-term memory (LTM). The duration (lifespan) of each type is deliberately mentioned at this stage because it is directly related to their functions. Sensory memory has duration of one second, short-term memory 15 to 25 seconds and long-term memory virtually a lifetime – "limitless" capacity and duration (Jordaan and Jordaan, 2000:292, 502).

4.2.2.2.8.1 Sensory memory

Sensory memory is the stimulus traces left by the bio-electrochemical pulses utilised in the monitoring process. The receptors are flooded with stimuli, but through monitoring only relevant information significant to the perceiver is selected for further processing – "passed on to the STM". Unconsciously the mind is continually differentiating incoming stimuli into relevant and irrelevant, significant and insignificant, validated by LTM content. The duration of sensory memory is just long enough for effective monitoring of pulses from the receptors – one second.

4.2.2.2.8.2 Short-term memory (STM)

Short-term memory is the working memory of the brain. It can be compared to the *Random-Access Memory (RAM)* of a computer. The perceiver is aware of the perceptions (decoded pulses) "allowed through" by the monitoring process for further processing. A limited amount of information is stored in STM in an ongoing process of new stimuli coming in and "old" items are fading (Lefrançois, 2000:265). Only a few items of information can be attended to simultaneously, therefore STM keeps the traces available for a short period of time for conscious attention and further unconscious mental processing (Jordaan and Jordaan, 2000:500). However, the duration and capacity of STM can be improved with specific techniques.

Acoustic format is a significant mode of retaining information for attention and further processing for a longer period although also a significant contributor to confusion. Repeating information to oneself extends the period in STM and improves perception. It is frequently used in rehearsal even though not always aloud and features as one of the facets in alternative memory theories.

Organising information into meaningful units ("chunks"), more significant to the perceiver, increases the intensity of attention given (Jordaan and Jordaan, 2000:501). Breaking up units into more appreciable items is one way of organisation employed. Grouping units into more perceptible propositions, mental scripts or schemas that are meaningful and significant to the perceiver, is another way of organising information. This technique is also utilised in rapid reading. Organising information into appreciable items or meaningful "chunks" extends duration and capacity of STM. Familiarity of the situation facilitates organisation and improves the process.

Rehearsal is a technique of focusing conscious attention on a particular item, unit or group of units. Repetition is a form of passive rehearsal with very little evidential success (Jordaan and Jordaan, 2000:502). It is, however, a way of keeping attention focused on specific information extending the lifespan of STM. A more effective way of rehearsing is to add significance to information by attaching qualities or spurs to it. More significant spurs are more effective (Jordaan and Jordaan, 2000:502). The conclusion is that multi-sensory exposure to information makes sense. The intensity of focus of attention on information can be improved by consciously elaborating on the concept, finding relationships and relevance – giving it more meaning (Sternberg, 2003:184).

4.2.2.2.8.3 Long-term memory (LTM)

The content of STM will be lost after rehearsal if it is not transferred into LTM (Lefrançois, 2000:264). "Transfer" of information into LTM entails recoding into a format compatible with the biochemical processes for retention of mental representations in the brain. The "limitless" capacity of the brain must be seen against the background of the multitude of possibilities (exponential expansion) in biochemical compositions and the possibility of utilising compositions repeatedly by altering relationships and links (Jordaan and Jordaan, 2000:186; Sternberg, 2003:271).

Effective "transfer" of information into long-term memory (LTM) is a major concern in education because it is the basis of learning and development. Information is learned if it is captured in LTM in retrievable format. The belief that all perceived information is stored in LTM is of no concern to education (Jordaan and Jordaan, 2000:500). Only what is stored in such a way that it is retrievable, and theories that support education practices, currently deserve attention.

Methods of prolonging the duration of STM will permit the storage of a bigger portion of the current information in LTM.

Comprehension is a method to enhance memorisation of information. Knowing more about information than just its existence makes it more meaningful (Woolfolk, 2010:250, 251). It provides additional processing capacity in terms of more relevance, more relationships, more links and more significance. Adding more declarative/descriptive and functional knowledge to a mental structure is a method of extending the duration and capacity of STM and consequently improves storage in LTM. It can be consciously achieved by focusing attention on these additional aspects.

In addition to unconscious association of knowledge the perceiver can consciously associate information with internalised knowledge (existing mental representations). Deliberately trying to link new knowledge with familiar knowledge will contribute to the processes of comprehension and storage. "Transfer" from STM into LTM can be further enhanced by integrating new information into internalised knowledge in a process of consolidation (Sternberg, 2003:182).

Mnemonic techniques can help memorising information – storing information in LTM (Sternberg, 2003: 185 – 187):

- Categorical clustering is organising information in categories based on relationships. Related items form a cluster.
- Interactive images are imagining the items to be represented by words interacting with each other in an active way. Imagine an image executing an action (verb) on another image.
- Peg system is a technique to remember lists of items. Words rhyming with the numbers (or letters of the alphabet) are chosen from each item to be memorised – association by sound and cadence. According to these words numbers are allocated to the items and the items rearranged in numerical order. The numbers (or letters) are well-established knowledge in terms of identity and order which can be automatically reproduced (ready knowledge). With the simple association the items are easily remembered.
- Method of loci is a systematic way of improving one's memory by establishing spatial relationships between outstanding landmarks along some familiar route and the information to be memorised. Associating information items with the landmarks or exceptional features enhances storing and recollection of the information. Recollection is done by taking an imaginary walk along the relevant route.
- Acronyms, in which each letter represents an item of the information to be remembered, can be constructed. The acronyms should make sense in some way or the other either by sound, familiarity or signifying order. Remembering the acronym and the associations

enables recollection of the information.

- Acrostics are poems or verses with specific recurring features in the first letter, syllable, or word of each line in the text spelling out an item, concept or denotation in the relevant information. Text may be own versions but needs to be automated in some way (ready knowledge). Recollection is through the association with the features incorporated.
- The keyword system is based on interactive image and concept association that links sound and meaning to new words or concepts. New words or concepts are associated with the sound and meaning of familiar words representing concepts. Recollection is based on recalling the keyword and association.

Storing information in an organised systematic way in LTM is a natural phenomenon, which should be emulated in learning opportunity planning and representation. Various models of information organisation in memory attempt to explain how stored information is organised, related, linked and retrieved. However, they cannot circumvent the established fundamentals of the psychology of learning. A significant issue seems to be how well-organised memory really is. Although different explanations are given and different terminology used, there is enough congruency to contend with the theories discussed. However, the schema-and-script model resembles the foregoing discussions.

There are indications that memory comprises different interrelated, supporting, interactive types (Jordaan and Jordaan, 2000:506). Each one is labelled according to the type of knowledge stored – declarative/descriptive which represents two subtypes, semantic and episodic knowledge, and procedural knowledge (Feldman and McPhee, 2008:93).

Although the cognitive processes involved are discussed in section 4.2.1.2, revealing the integrated nature of cognition is necessary. Memory traces left by bioelectric pulses during monitoring are sensory memory. Sensory memory enables STM functioning. Early stages of mental processing, perceptual organisation and conceptualisation rely on STM for effective transformation of the information into storable format. Transformation of the information into a brain-compatible format is capturing it in LTM. The information processed in the central nervous system is retained in some biochemical form. When new information is assimilated it is stored in memory (LTM). All these processes are interdependent, interrelated and integrated in cognition.

Memory characteristics significant to unsuccessful school leavers' education

LTM has general characteristics significant to education. They are features in the discussion of the cognitive processes, but the following versions are from a memory perspective (Lefrançois, 2000:268):

- LTM, unlike STM, is steady and long-lasting. Information detected by different receptors is not stored equally efficiently, e.g. smell is recollected more efficiently than visual and verbal information and is more resistant to interference.

- LTM content is not true replication of information perceived. Every perceiver constructs his own version of reality from information perceived, related mental representations (existing memory content) and frames of reference. Perceptions are susceptible to interference, influenced by state of mind of the perceiver and the outcome of the primary perceptual processes, monitoring and STM. Concepts may be left out or added, causing generation of content rather than recollection.

- LTM content is improved by comprehension (Woolfolk, 2010:250, 251). Comprehension gives more meaning to perceived information (experience) resulting in more efficient STM and processing. It also reduces the deviation of memory content from reality. Some detail may be left out or reproduced wrongly if relevant knowledge for reference, support or association is lacking.

- Some information is captured more easily in LTM. Significant, striking and meaningful information is captured more easily than insignificant, boring and meaningless stimuli. The active involvement of the perceiver enhances transfer of information into LTM – affective and volitional.

Remembering information is of paramount importance to education. Retrievable memory content is proof of learning and the basis of competence in cognitive, psychomotor and automated activities. Special attention should be given to the processes and techniques of memorising the learning content and perceptual-motor learning. The latter is often exercised to the level of automation – unconscious execution. Equally important is recall of the learning content and demonstration of competence. These revelations that learning has actually taken place are the culmination of various complex mental processes.

Not everything perceived is remembered. Although vast amounts of information are stored in LTM – more than what is consciously perceivable – there is an inability to effectively retrieve memory content. Memory content can be divided into accessible and available memory information. Not all the memory information that is available is accessible (Jordaan and Jordaan, 2000:510). Forgetting cannot be attributed to limited memory capacity, but rather to inability to retrieve memory content. It is however, considered a method of "getting rid" of useless information (Louw and Edwards, 1993:313).

Retrieval entails re-decoding of the information to make it perceivable in the mental processes.

Making the memory content perceivable is a process of converting (re-decoding) it into bio-electrochemical pulses. Memory content is constructed reality. How close to the "desired product" it is depends on the stimuli, the processes, existing mental representations and associations made. Retrieval also comprises certain mental processes which may influence the construction and quality of the recollection. However, what is retrieved (re-decoded) depends on what was decoded.

Retrieval can be a process of searching or reconstruction (Woolfolk, 2010:252). Searching is based on monitoring, mainly unconscious searching for matches – partially ***an unconscious process of mental "determination" valuable in examination writing***. The process of retrieval depends on how the information has been memorised, how it was encoded at the time of learning and the cues that were provided (De Corte and Weinert, 1996:275; Jordaan and Jordaan, 2000:510). Cues and the ability to apply them substantially influence the capacity to retrieve information from LTM. Cues are any form of information/hint that facilitates retrieval.

Reconstruction is a process of retrieval where fragments of information (memory traces) are reconstructed into a recollection of the desired information (Jordaan and Jordaan, 2000:513). The recollected information is the product of the mental processes involved in the construction of the mental representations and reconstruction processes in retrieval.

Frequently used information is recalled easier than information seldom attended to. This emphasises the value of relearning (Jordaan and Jordaan, 2000:516). More meaningful repetition of information like application, changing format or inventing challenges will improve remembering and provide additional cues for retrieval. It is good learning practice to use learned information as many times as possible. ***This emphasises the value of application and problem solving, signifying application in different situations.*** More effort in learning will inevitably pay off when the information is needed.

Proficiency enhances confidence in memory content and retrieval. Existing mental representations (e.g. concepts, schemas) improve storing and retrieval of information (Woolfolk, 2010:250). These mental representations provide the context for processing new information and cues for retrieval.

Vividness and richness of detail in perceived mental representation give greater confidence in the accuracy of recollected information. These features are complemented by attributing more meaning to information, relationships, relevance and significance to learning material. Comprehension assigns even more meaning contributing to the value the information has to the perceiver. Louw et al (2008:316) posit, "So the more you understand the better you remember."

Emotional involvement may provide motivation for effective memorisation and retrieval of information. It further contributes to the assigning of meaning to information. Negative emotions will have a negative effect on remembering and retrieval. According to De Block's taxonomies of learning objectives, learners are cognitively, affectively, psychomotor and volitionally involved in the learning process (Krüger and Müller, 1990:48). Learners' readiness to learn includes emotional state of mind.

State of consciousness is fundamental to learning. Together with emotion, these two factors are determinants in receptiveness. Learning needs a mental state favourable for perception and further processes involved in cognition. For retrieval of information the same preconditions apply.

Deliberately ***organising the material***, when learning, in the same way as the expected method of retrieval will enhance recollection. At first, the material and the processes should be organised to facilitate learning (remembering) (Louw et al, 2008:289). Considering how it will be applicable and useful, replicating retrieval, in the organisation of learning is a further step in providing for effective recollection.

Previously learned material may interfere with the recall of material memorised later; psychologists call this ***proactive interference***. ***Retroactive interference*** occurs when material learned later interferes with material memorised earlier. The closer the relationship between the types of material the stronger the possibility of interference. Proactive interference is more likely to occur because there is always more previously learned material than new material in memory (Sternberg, 2003:194).

These effects are most prominent in test series and examinations where schedules are tight and learning time limited. Learners need time to ***relax*** before writing a test or an examination subject – how long depends on each individual. It is not good practice to start preparing for a forthcoming subject just before writing a current one. Learning should be done according to well-structured schedules especially for examinations. Within the schedule each subject should have a study plan structured according to the subject structure, which should be concluded in good time to allow settling down time. The conclusion should be a well rounded-off schema – written and mental.

4.2.2.2.8.4 Declarative memory

Declarative knowledge, stored in declarative memory (*propositional memory*, Louw et al, 2008:289), described in a following section 4.3.3.1, comprises facts and events experienced. It is factual knowledge revealing *know that* and *know what.* It comprises awareness of existence, composition, theories, relationships, features, location, links, situations, events and chronology. These are divided into semantic knowledge and episodic knowledge.

Semantic knowledge describes things, people and situations – specific but comprehensive knowledge about reality in general. Episodic knowledge is representations of experiences, circumstances and related affective knowledge – how reality was experienced and the affections involved (Lefrançois, 2000:272).

4.2.2.2.8.5 Procedural memory

Procedural knowledge, stored in procedural memory, is the mental representation of *knowing how* also discussed in 4.3.3.2. It is the knowledge fundamental to perceptual-motor skills enabling execution of tasks often to impressive perfection: artists, tennis players, gymnasts, skiers and craftsmen, to name but a few (Louw et al, 2008:289). Many actions required in everyday life are executed unconsciously – automated so that they are performed without thinking about how to do it. Declarative and procedural knowledge are stored in different part of the brain.

4.2.2.2.8.6 Alternative working memory theory

An alternative theory for the role of working memory posits that it holds the activated (conscious, retrieved) portion of LTM, STM and processes. Considering the mind as resembling computer functions, including the Working Memory Theory is presented by Feldman and McPhee (2008:46) as attributable to cognitivism. These theories present a more integrated function of working and long-term memories with expanded explanations on the processes involved. According to Sternberg (2003:161) the Working Memory Theory's memory comprises a visual sketchpad, a phonological loop, a central executive, a number of subsidiary slave systems and an episodic buffer.

The visual sketchpad is for temporary visual images, the phonological loop is for inner speech when performing verbal comprehension and rehearsal, the central executive is for coordinating attention and controlling responses, the subsidiary slave systems for perceptual and cognitive tasks and the episodic buffer is for integrating information from different parts of working memory to make sense to the perceiver. Working memory moves items into and out of temporary storage.

Woolfolk (2010:240) distinguishes between working memory and STM because working memory includes "temporary storage and active processing," which incorporates retrieval from LTM. STM just denotes temporary storage of new information for about 15 to 20 seconds. However, the processes discussed in 4.3.2 incorporate STM as a stage in the integrated processes of perception and knowledge construction. The working memory theory is therefore an integral part of the psychological theory of cognitivism's computer metaphor.

Different theories explain these functions in different modes. Although the terminologies of these theories differ, there are resemblances in functions of the different elements (Sternberg, 2003:158–166).

4.2.2.2.9 Imagination

Imagination is experiences and activities perceived mentally, not reliant on incoming stimuli although often initiated by environmental perceptions. It is therefore not direct environmental interaction with the individual. Cognition can also be internal mental activities in the absence of sensory sensation (incoming stimuli). People make symbolic representations of previous perceptions and experiences in their minds, which enable them to construct images, concepts and imaginary events they have not experienced in reality (Barnard, Kemp, Van der Merwe, Theron, Grobbelaar and Botha, 1966:109). They can consciously reorganise and manipulate symbolic representations (memory content) to find new relationships, new arrangements and new meaning in generating ideas, imaginary events and prospective conduct.

Constructing innovations mentally and actualising them practically is fundamental to technological progress and human advancement in general. Everything achieved by mankind can be attributed to this unique ability, imagination. The inherited driving force in mankind urges constantly towards continuous improvement of conditions and progress (Hamilton, 2008). Work smarter instead of harder – learn smarter instead of harder and with innovation through imagination, results can be realised.

4.2.2.2.9.1 Features of imagination

Imagination makes people aware of much more than can be perceived with the sensory organs. It opens up a world beyond environmental reality not confined by laws, theories and rules. Anything is possible: new structures, new combinations, new concepts, new events and experiences, all imaginary. "In the imagination of man exist the seeds of all moral and scientific improvement" (Walsh, 1960:23). Past experiences can be reconstructed into mental anticipation of future events, task execution, results of activities or conduct. Mental activities like these bring about new inventions, literature, paintings, theories and solutions to problems. It can feature many forms: ***chess moves***, ***problem solving***, ***innovation***, ***anticipation***,

daydreaming, fantasising, fiction, hypothesising, planning and ***designing***. Imagination features prominently in ***problem solving*** and ***critical thinking*** constituting mental activities of anticipated actions and/or events. ***These features render methods of improving this ability of learners a feasible aspect of education for unsuccessful school leavers.***

Unconsciously concepts, schemas and images are going through the cognitive processes of conceptualisation to form new mental constructs (Sternberg, 2003:215). Mental constructs conceived in the mind rather than perceived from sensory stimuli are the fundamentals of ***innovations*** and ***inventions***. Everyone has the ability of imagination, probably in various degrees. Imagination utilises representations of stimuli from all five receptors: visual, audio, smell, taste and touch sensations. It is closely linked to mental manipulation of images (mental handling of "objects") (cf. 4.2.2.2.6). Imagination is the ability to construct and visualise ideas – creativity is bringing these ideas into existence.

4.2.2.2.9.2 Methods to develop imagination

"***Imagination is the distinguishing characteristic of man as a progressive being and it ought to be carefully guided and strengthened as the indispensable means and instrument of continued improvement and refreshment***" (Walsh, 1960:23). Development of, and guidance in, imagination should be implemented in education to strengthen critical thinking and problem solving. The following list contains a number of suggestions to improve imagination:

- Switch off logic, fantasise and write down your fantasies. Make sure to get a daily exercise in imagination.
- Be interested in everything. Many events, knowledge and objects pass virtually unnoticed. This can expand your foundation for imagination. Curiosity is a virtue.
- Exposure and experience are opportunities. Be on the lookout for benefits. These can expand your foundation for imagination.
- Develop sensitivity and receptiveness to opportunities.
- Rely on your own ability to think. Mentally manipulate concepts and schemas. Take an imaginary walk down a mental map. Watch travel, nature and technological programmes on TV and take imaginary trips around the world to interesting places.
- Association with creative people provides opportunities to learn from them. Think about the knowledge and experiences perceived.
- Reading creative and technological literature develops powers of perception – constructive thought.
- Write fiction. Imagine situations, events and experiences and make yourself the hero who saves situations with innovative thinking and creative actions. Imagine designing a car or

any object incorporating improvements and put your thoughts in writing.

- Be on the lookout for improvements to be made on items in everyday use and new techniques to simplify and/or improve execution of tasks. Make sketches and illustrations from your imagination.
- Build on ideas of other people and elaborate on your perspective. Record your imagination.
- Problem solving relies on imagination. Make a study of techniques, methods and procedures.
- Imagine yourself 5, 10, 20 years in the future. Decide what you want to be, where you want to be after a specific period of time (Hamilton, 2008).

Imagination control is essential for constructive thought and an organized lifestyle. Concentrate on positive significant experiences and visualise innovative constructive improvements. Imagine ways to make assignments easier, better and learning more enjoyable. Creativity and positive behaviour will follow. Avoid negative thought and emotions leading to destructive imagination. Negative thought is a descending spiral into a negative lifestyle (Du Toit and Van der Merwe, 1972:280). Visualise your status and position after 10 years of creative living and newly found freedom – freedom initiated by positive imagination. ***Imagination is mental innovation and creativity substantial imagination.***

Memory content (mental representations) is the substance and equipment of imagination. The concepts, schemas, images, frames of reference and links are the material needed for imaginary processes. Only relevant mental representations can produce a desired imagination, e.g. a solution to a problem. An educator may conclude that a "bigger pool" of knowledge and experience has more potential for these activities.

Imagination is not well documented in current psychological literature. It appears in discussions on creative thinking, problem solving and art just as an aspect of human thought.

4.2.2.2.10 Mere exposure effect and priming

The mere exposure effect is not an outstanding psychological theory, but it has merit in mind preparation. People tend to develop a preference for things merely because they are (briefly) exposed to them (Louw and Edwards, 1993:788, 789). Repeated exposure facilitates perceptual processing because of familiarisation. Exposure below the detection threshold can be detected unconsciously and can influence meaning about other stimuli following closely (Jordaan and Jordaan, 2000:294). The effectiveness of this last assumption is, however, doubtful. All that needs to be ***true for education is that prior exposure brings about familiarity and evokes interest.***

Priming in psychological terms is facilitation of processing of stimuli by prior exposure to these stimuli or similar stimuli (Sternberg, 2003:68, 151, 152, 299, 300). Fleeting presentation of stimuli are sensory recorded, (unconsciously) processed and available for later processing of the same stimuli or closely related stimuli. Although not fully attended to at exposure, stimuli are unconsciously processed and recorded. Comparing this theory to monitoring, leads to the conclusion that not all currently "unprocessed" information is lost.

Priming, being intentional exposure to specific stimuli, has merit in mind preparation of learners. Deliberate prior ***introduction of key concepts of information to learners will improve learning of that specific information*** at a later stage. In a classroom situation deliberate priming will be more successful because competition from other stimuli is eliminated.

These two less prominent theories can be implemented successfully in mind preparation for forthcoming learning opportunities for unsuccessful school leavers. ***Appealing introduction of new information, bearing these phenomena in mind, can evoke curiosity and anticipation for the next learning opportunity***.

4.2.2.2.11 Attention – Mental state effecting learning

Attention is the cognitive process of consciously focusing and selectively concentrating on one aspect of reality (environment) while disregarding others to deal effectively with that aspect. The subjective involvement of the perceiver is decisive (Krüger and Müller, 1990:48; Jordaan and Jordaan, 2000:324).

4.2.2.2.11.1 Attention fluctuation

Attention fluctuation is caused by disturbances. Environmental stimuli flood the senses, but only significant and outstanding stimuli can interfere. The brain is continuously monitoring and processing environmental stimuli and will bring significant stimuli to the perceivers' attention (fluctuating) e.g. hunger. Monitoring will select environmental and internal stimuli important to the perceiver for further processing and only significant stimuli can cause attention fluctuation (Jordaan and Jordaan, 2000:326, 327). Significant stimuli – loud noise, visual perceptions and disruptive activities – will interrupt attention.

An educator doing something irrelevant, e.g. playing with an object while presenting learning content, will evoke fluctuation of attention. Vision receptors need movement to remain active. Movement is therefore more easily detected. Educators should therefore, refrain from irrelevant movements in learning opportunities.

Maintaining attention by administering the stimuli in varying forms to keep it significant to the perceiver, preventing habituation, is an important technique for education. Significant changes cause dishabituation and attract attention (Jordaan and Jordaan, 2000:328).

4.2.2.2.11.2 External determinants of attention

- Intensity, size and distance: striking stimuli, significant stimuli and closer stimuli are more compelling.
- Change, movement and contrast: change inhibits physiological habituation, movement attracts attention, contrast "intensifies" stimuli.
- Repetition followed by something different focuses attention on specific stimuli.
- Complexity evokes interest and is challenging, but it relates to level of development of the perceiver and therefore to aptitude. Variation in the level of evoking complexity occurs between individuals and also in an individual at different times. The level of complexity is critical in education because it may be compelling or repelling. (Jordaan and Jordaan, 2000:335; Woolfolk, 2010:239)

4.2.2.2.11.3 Internal determinants of attention

- Subjective disposition
  - Perceptual sets – Readiness
  - Arousal level
  - Needs
- Emotional state
- Physical wellness (Jordaan and Jordaan, 2000:337)

Perceptual sets are states of readiness in anticipation of exposure to information related to personal dispositions. Reasons for significance and motives are underlying anticipation generated from existing mental representations.

Arousal level and accompanying stress reveal a relationship with attention and performance level. Optimum attention and performance are reached with moderate levels of arousal and stress. Most tasks are performed optimally at moderate levels of arousal, but new and complex tasks require a level just below moderate. High levels of arousal and stress are detrimental to performance. Low levels also do not bring about desired levels of performance. However, simple tasks are less affected by the arousal and stress levels. Inviting, challenging learning content can evoke just the right amount of stress.

Needs and discomfort are strong challengers to information if they compete for attention. The significance of information (learning material) is threatened if needs or discomfort turn learning opportunities into unpleasant experiences.

The emotional state (mood) of learners is another factor that will influence classroom atmosphere and involvement of learners in learning. A friendly, relaxed atmosphere is conducive to productive learning. Learning opportunities can be inviting occasions facilitating the aspects of effective education. The mood of a learner determines his attitude and therefore his approach and attention to, and effectiveness of learning.

Physical wellness is an obvious determinant of attention. Illness will get precedence over information and the mental ability will be negatively affected. The mood of an ill person will not favour attention and mental processing of information (learning).

Getting the attention of learners is important, but maintaining it even more so. Attention is the initiation of sensory experience and mental processes involved. Fluctuation or interruption of attention will consequently disrupt the mental processes, leading to misconception. Adding attention and influences to learning opportunity premises will contribute to learning and effective education (Sternberg, 2003:99; Feldman and McPhee, 2008:96; cf. 4.2.2.2.11).

4.2.2.2.12 Comprehension

Comprehension is an essential consideration in unsuccessful school leavers' education. Their educational attributes suggest poor learning ability which can be enhanced by improvements possible with comprehension. The duration of STM can be extended and thereby allow more time and increased STM capacity for mental processing of information. More significance is added to information with comprehension, improving its relevance to the learners. Comprehension provides additional processing capacity in terms of more relevance, relationships, links and significance. These factors together improve LTM storage (Woolfolk, 2010:260). Comprehension is therefore a more significant attribute of the learning process than repetition (cf. 4.2.2.2.2).

Repetition has only value for unsuccessful school leavers' education in acquisition of ready knowledge, accomplishment of automation of procedural knowledge and extending the duration of STM. The latter may eliminate follow-up information from conscious attention when repeating specific information. Repetition as substitute for comprehension results in learners' inability to operate beyond regurgitation of memorised knowledge – Bloom's cognitive level of remembering. Unsuccessful school leavers need to be able to do something with acquired knowledge and consequently need higher levels of cognition.

Learner development pivots about the acquisition of knowledge, skills and values and each one requires comprehension of the learning material, procedures and ethics involved. With comprehension as a norm, educators should be familiar with the concept (declarative knowledge) and the criteria to determine accomplishment. Comprehension is more than *knowing that* and *what*. It involves frames of reference, links, relationships, identification and categorisation in mental processing (Sternberg, 2003:248; Woolfolk, 2010:260).

Prior to comprehension a whole sequence of mental processes, from awareness and identification to classification, must be completed. In constructivist terms comprehension incorporates the processes of generalisation, modification and construction of new structures enabling application beyond the original situation – understanding in terms of Benjamin Bloom's revised taxonomy of learning (Forehand, 2005:4 of 7). It involves the establishment of new links, and recognition of relationships and relevance. It is a process of conceptualisation.

Comprehension, being a mental state accomplished, begins with the construction of new mental representations and frames of reference. Stimulus (information) detection, identification, recognition, categorisation and organisation precede the construction of mental representations. Links are established between new mental representations and other constructs including frames of reference. Recognition of relationships, relevance and significance suggest comprehension of new information. Further confirmation is mental manipulation and establishment of new relationships and identification of new links. However, confirmation depends on intersubjectivity and context in reality. Although comprehension can be corroborated independently, the criteria are based on the consensus reached with environmental interaction. Learning by insight denotes the ultimate form of comprehension.

The premises for comprehension in an educational situation, resembling the premises and conditions for perception, are:

- physiological readiness
- level of arousal (expectation) and preparedness of mind (receptiveness of perceiver)
- attention
- significance of the information to the perceiver
- a foundation of internalised knowledge (existing mental constructs) for new information
- relationship with internalised knowledge (prior knowledge)
- active involvement of the perceiver
- multi-sensory experience
- good teaching practice (Woolfolk, 2010:260).

The criteria for comprehension are derived from Bloom's revised taxonomy of cognitive learning. The criteria compiled for this level is further elaboration on comprehension. The following abilities are indicative of comprehension as a state of mind accomplished:

- interpret (assign meaning)
- classify/distinguish (arrange or categorise according to attributes)
- exemplify (illustrate by example)
- explain (make clear with detailed information)
- translate (express in alternative terms)
- interrelate (determine similarity and relevance)
- summarise (reduce to essentials)
- apply to simulated and real situations
- infer (deduce features, meaning, significance)
- extrapolate (infer more widely – adding information, features and/or attributes)

These criteria confirm that *understanding* would be an understatement of *comprehension.* The complex mental processes involved, ranging from receptor stimulation as initial stage of perception to structuring and restructuring of comprehensive mental representations, complicate exact description and specific range of comprehension in terms of the psychological theories of learning. It is, nevertheless, important to know that comprehension qualifies "knowledge" for functional application, dynamic thought, imagination and learning by insight – higher order mental activities.

The absence of comprehension renders all knowledge acquired virtually reproductive status – it can only be regurgitated. Learners will have limited ability to identify and apply. With exclusive knowledge of "*how to do it*", learners will find it difficult to transfer knowledge to different situations. Learner development will be hampered if learning does not exceed the confines of "how to do it" (Sternberg, 2003:254, 266). ***Unsuccessful school leavers need to accomplish higher order cognition for education foundation construction and capacity building.***

4.2.3 KNOWLEDGE IN UNSUCCESSFUL SCHOOL LEAVERS' PERSPECTIVE

In the absence of a single distinct definition for knowledge and an ongoing epistemological debate, the constructivist line of reasoning will be sustained. Knowledge is regarded as information based on intersubjectivity and viability processed into mental constructs by individuals. The results, referred to as knowledge, are normally stored in memory for later retrieval and utilisation. In the preceding sections the cognitive processes involved were discussed. Knowledge can be acquired through situational or education experiences, but experiences comprise more than exposure to information. Experience is a holistic, multi-facetted occurrence entailing multisensory stimulation and volitional, affectional involvement (Jordaan and Jordaan, 2000:282-284). However, knowledge as mental representations (constructs) is the initial concern in education, and also a means to holistic edification of the learners.

"Knowledge representation comprises various ways in which our minds create and modify mental structures that stand for what we know about the world outside of our minds. Knowledge representation involves both declarative/descriptive (knowing that) and procedural/imperative (knowing how) forms of knowledge" (Sternberg, 2003:248). This classification is an intention to distinguish between the functions of the two forms of knowledge in human existence and behaviour. Knowledge is also differentiated into types mainly based on the methods of acquisition (memory). A different approach will be used for the envisaged curriculum, categorising applicable knowledge according to purpose, acknowledging the integrated nature of knowledge and mental functioning.

4.2.3.1 Knowing that

Declarative/descriptive knowledge (knowing that), incorporating concepts, propositional networks, images, spatial configuration, relationships and temporal strings/information (sequencing of actions and events), are mental representations of factual knowledge. It is knowledge about reality – describing that things are and what things are – comprehensive information, even *about* procedures, but excluding the *how* thereof (Rosenbaum, 2010: 117). Declarative knowledge incorporates higher order mental representations.

4.2.3.2 Knowing how

Procedural knowledge (knowing how) is the mental representation of the dynamics of mental constructs, most often on the preconscious level, but available for cognitive processes and even conscious mental activity (Jordaan and Jordaan, 2000:470; Rosenbaum, 2010: 117). It is the knowledge utilised when executing a task – the mental processes enabling psychomotor activity. It comprises mental scripts; preconditions *(if)*; rules; conditions and procedure: routines, subroutines and techniques *(then)* – the production system (Sternberg, 2003:270). What is often referred to as intellectual skills – knowing **how** to accomplish the motor activities accompanying cognitive tasks – is procedural knowledge mostly on the preconscious level and applied automatically, e.g. artists, sportsmen, musicians, gymnasts and motorcar driving (Jordaan and Jordaan, 2000:474, 478).

Knowledge representation of procedural skills occurs in three stages: the cognitive, associative and autonomous stages (Woolfolk, 2010:258). The cognitive stage entails thinking about explicit rules and actions for implementing the procedure. Execution of the procedure according to the rules and actions is the associative stage. Experience in the execution of the procedure develops into implicit implementation of the rules and actions with a high degree of integration and coordination in the autonomous stage. Everything is integrated into a single, coordinated series of actions executed automatically, without consciously thinking about each action and sequence. Composition of a range of processes into a procedure is done by combining single actions into groups and the groups into an integrated procedural network.

Procedural knowledge cannot be acquired effectively by observation. Observation of execution of procedures is merely declarative knowledge (knowing that/what). To progress to procedural knowledge active execution of the processes involved, should be accomplished (Sternberg, 2003:68).

4.2.3.3 Declarative and procedural knowledge relationship

The relationship between declarative and procedural knowledge can be concluded with examples: making a thorough study of tennis and the strategies and techniques of a champion cannot convert a novice into a match for the champion. His knowledge may match the declarative knowledge of the champion but it will lack the capacity to match the champion's game. Similarly, a learner can study mechanical procedure from a workshop manual and match the declarative knowledge of an artisan, but that does not make him a competent artisan. In both cases the subject needs procedural knowledge, which may be partially revealed in the strategies and techniques to accomplish the capacity. Procedural knowledge implies perceptual-motor activity that requires active participation and repetition to take it through the three stages of cognition, association and automation. Not everything develops into a stage of unconscious execution, but automation reduces reaction time and leaves additional "room" for mental processing.

Transfer of the procedural network of knowledge to other situations is possible through complementary generalisation and discrimination – generalising actions and mental scripts directly transferable, discriminating against differences and adapting (new information processing) to new scenarios (Sternberg, 2003:271).

Discussing the mental activity of humans step-by-step should not impair the Gestalt theory of cognition embodying order, regularity, symmetry, simplicity, harmony, completeness and holistic approach. Human mental processes are an integrated aggregation of cognitive activities, which include declarative and procedural knowledge construction. The relationships between declarative and procedural knowledge is best demonstrated in intellectual skills.

4.2.3.4 Intellectual skills

Intellectual skills are the "know-how" of mental representations. This refers to the capacity to mobilise procedural knowledge and knowledge in general (Jordaan and Jordaan, 2000:479). Much of the knowledge is unconsciously mobilised: writing skills, driving a motorcar and tacit knowledge, for instance. Discrimination, association, concept and rule formation are intellectual skills. Propositions that express relationship between concepts, are rules.

Metacognition is awareness of how own cognitive processes operate, control over these processes and ways to enhance the processes – knowing how one's own mind functions, control of these functions and techniques to enhance these functions (Sternberg, 2003:183). Metacognitive knowledge can be communicated, develops through experience, enables control over cognitive processes and is fallible. It features in critical reasoning, analysis and synthesis of task execution, monitoring strategies, error identification and location, and track keeping of progress (Jordaan and Jordaan, 2000:482). Metacognition is the culmination point of the hierarchy of intellectual skills (Jordaan and Jordaan, 2000:483).

Learning is predominantly cognitive. Cognitive processes feature in conceptualisation, perceptual-motor skills, other muscle-driven activities (motor activities) and behaviour in general. In the autonomous phase it is still prevalent although unconscious. Control over cognitive processes is learning how to learn – metacognitive ability.

Learning consists of complex psychological processes, resulting from multi-sensory stimuli, which cannot be comprehensively described in a single-facetted approach. However, the systematic explanation should be regarded as fractions of more complex and comprehensive processes. They constitute the fundamentals required for unsuccessful school leavers' education and effective learning. This account of psychological learning theory covers aspects considered fundamental to unsuccessful school leavers' education.

4.3 ACCOMMODATING LEARNER DIFFERENCES

Learners differ in terms of mental capacity, physical features, abilities and aptitudes, with a range of different abilities. These differences should be taken into account in unsuccessful school leavers' education to achieve optimum results in learner development. Expanding success to all the learners is the intention with unsuccessful school leavers' education. Learners should accomplish results in accordance with their potential. In an attempt to pursue the ideal relevant features of Bloom's revised taxonomy in the cognitive domain, learning style theories and multiple intelligences are evaluated.

4.3.1 COGNITIVE DOMAIN OF BLOOM'S REVISED TAXONOMY OF LEARNING

Benjamin Bloom's taxonomy of learning is not a learning theory but rather differentiated criteria for learning achievements or prospective achievements. These criteria, although not critically divided, provide a means for classifying learning outcomes according to mental skills which are directly related to levels of competence (Forhand, 2005:1). Elaboration in terms of the mental processes involved in learning provides further motivation for the envisaged educational practice aiming at diverse levels of development, multiple exits and links to further education and training.

Although Bloom's taxonomy classifies learning outcomes in levels of complexity, it also provides criteria for learning opportunity construction and learning opportunity presentation. Incorporating these criteria into the opportunity design schema affords educators the chance to cater for different aptitudes and levels of development. Key to this prospect is ***inclusion of the lower performing learners without neglecting the higher performing group***. In Bloom's taxonomy reflections on learning theories and knowledge classification can be observed. A revised version of Bloom's taxonomy by Anderson and Krathwohl (2001), as reported by Forehand (2005), is the basis for the discussion. In this revised version the two upper levels are switched. Synthesis, renamed creating, is considered the highest cognitive skill level or degree of difficulty by Anderson and Krathwohl (2001). However, the upper three levels are sometimes considered equal in difficulty and complexity (Chapman, 2009).

Bloom's taxonomy of learning objectives as revised by Anderson and Krathwohl, (2001), has the nouns changed to verbs (Forehand, 2005:3):

- **Remembering** refers to the ability to retrieve, recognise and recall relevant knowledge from long-term memory.
- **Understanding** refers to construction of meaning through interpreting, exemplifying, classifying, summarising, inferring, comparing and explaining.
- **Applying** refers to carrying out procedures through executing or implementing.
- **Analysing** refers to dismantling material into parts, determining how parts relate to one another and to an overall structure or purpose through differentiating, organising and attributing.
- **Evaluating** refers to making judgements based on criteria and standards through checking and critiquing.

- **Creating** refers to putting elements together to form a coherent or functional whole; reorganising elements into new patterns or structures through generating, planning or producing (Forehand, 2005).

Fisher's (2005), in Forehand, (2005:4) a two-dimensional table of Bloom's taxonomy (Table 4.1) provides further clarification and elaboration on the criteria. Knowledge, as a second dimension to the taxonomy, is divided into four categories, factual and conceptual knowledge in the descriptive category, procedural knowledge and meta-cognitive knowledge. A comprehensive layout of the taxonomy, with reference to Table 4.1, is given in Appendix A.

Table 4.1: Revised Bloom's Taxonomy

The Knowledge Dimension	**The cognitive process dimension**					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge	List	Summarize	Classify	Order	Rank	Combine
Conceptual Knowledge	Describe	Interpret	Experiment	Explain	Assess	Plan
Procedural Knowledge	Tabulate	Predict	Calculate	Differentiate	Conclude	Compose
Meta-Cognitive Knowledge	Appropriate Use	Execute	Construct	Achieve	Action	Actualize

(Fisher, 2005 in Forhand, 2005:4)

Considering the criteria of "evaluate" in the range, these appear to be the highest level of cognitive skills. "Create" on the other hand, seems to be closer to "apply" resembling synthesise and should follow "Analyse." The processes labelled under "Create" reveal valuable knowledge and experience essential for evaluation signifying its position "below" evaluate. "Create" should precede evaluation because it provides the developmental stage for progress towards evaluation skills (Chapman, 2009:4). "Generating hypotheses" would complement "Evaluate". Table 4.2, below, illustrates the point.

Table 4.2: ***Revised Bloom's Taxonomy Comparative Criteria List***

Evaluate	**Create**
Judging according to criteria and standards	Restructuring
Examining conclusions made	*Generating hypotheses*
Critiquing – weighing methods, techniques	Planning a project
Ranking policies, issues	Producing – execution of a project
Assessing information, methods, techniques	Combine ingredients to produce
Concluding on outcomes of occurrences,	Decision making, personal and professional
Applying concepts in programmes	Composing according to guidelines
	Actualising social behaviour

However, the taxonomy is an excellent framework for the criteria needed in the education of unsuccessful school leavers. The version below, adapted for the envisaged education, is more perceptual-motor learning orientated, based on the notion that all behaviour is cognition-driven.

- **Remembering** refers to the ability to reproduce learned content/information, replicate perceptual-motor activities and imitate behaviour. The results will be each learner's own construction of the information presented. Perception and conceptualisation will be recognition, generalisation, categorisation and assimilation of the new information with existing mental representations.

  This assimilated information is what the learners will be able to retrieve and reproduce.

- **Understanding**, with "remembering" as prerequisite, refers to construction of meaning and the ability of mental manipulation of the learned content. It is accomplished, often unconsciously, with recognition of new relationships, relevance and significance. Mental manipulation and establishment of new relationships and identification of new links, confirm understanding.

  Demonstration of accomplishment will be added value to "reproduced" content and recognition of relevance beyond the original situation.

- **Applying** requires a foundation of "remembering" and "understanding." It refers to carrying out procedures including psychomotor activities and application of theories and rules. Constructing clusters of propositions (units of knowledge), ranges of images and dynamics, mental scripts and anticipating reactions constitutes the ability to apply learned content.

Competence is demonstrated by applying sequences of actions in procedures to situations, assignments, tasks or projects and the implementation of knowledge in conduct.

- **Analysing,** presupposes mastering of the lower levels of cognition, refers to dismantling content into elements, determining relationships, recognition of structure(s) and determining principles and function(s). Mental activity involves recognition, discrimination, association and categorisation. These mental representations are assembled into new schemas and frames of reference that form the bases for future analyses.

  Assigning new meaning to the whole by describing attributes, functions, relevance and relationships of the elements, is demonstration of capability. Recognition of principles and procedures in analysis concludes competence.

- **Synthesising**, also founded on the preceding levels, refers to assembling elements into new patterns, structures, systems or ideas. The mental processes involve identification, association and categorisation, fitting new information into established mental frames and constructing new mental representations. Operating in unfamiliar territory, construction of new mental representations and frameworks will be prevalent contributing to thought processes and imagination. Mental manipulation of the elements, similar to playing chess, is part of the thought processes contributing to success. Outside of conscious awareness, continuous processes of trying to make sense of sensory stimuli in terms of existing mental representations are in progress. Hypotheses about relationships, relevance and significance of these stimuli with existing mental constructs, are formulated (Sternberg, 2003:103).

  Coherent and functional wholeness of results, thorough planning/design and production, enthusiasm about challenging prospects, composition of new ideas/procedures, acquisition of new mental assets and innovation distinguish this level of cognition.

- **Evaluating** refers to making judgements based on internal evidence (knowledge) and/or external criteria for approval of concepts, theories, procedures, methods and techniques. In addition to appraisal of these "instruments" at the disposal of own mental assets, perceptual-motor skills, virtues and inventions are scrutinised. Systematic assessment of own performance enhances experience and contributes to development of appropriate skills. The mental processes involved are mainly developed through experience. Effective judgemental abilities are constructed on relevant declarative knowledge, procedural knowledge and reference frames (internalised "benchmarks"). In the mental processes information is unconsciously monitored, making the applicable information available for further processing. Through monitoring, relevance is determined by significance to the perceiver in terms of existing mental representations. Known information gets precedence over unfamiliar information. The information is weighed against existing mental constructs, schemas and frames of reference. New mental representations and schemas are formed including judgemental responses through the mental processes of recognition, categorisation, assimilation and referencing.

Effective judgements are only possible when thorough knowledge of the topic and appropriate knowledge of the evaluation procedures are mastered. Competence is demonstrated through motivated appropriate judgements and selections (Forhand, 2005:6).

Bloom's adapted revised taxonomy of learning outcomes provides the criteria for differentiating unsuccessful school leavers' results into different levels of accomplishments. This differentiation, further signified by the curriculum structure, affords different prospects for learners to pursue. Bloom's revised taxonomy of cognitive learning outcomes provides the theoretical framework for accommodation of learner differences.

Further, probably more practicable contributions to accommodate learner differences on can possibly be found in learning style theories and multiple intelligences.

4.3.2 LEARNING STYLE THEORIES

Learning-style theories are an assortment of diverse notions asserting the establishment of traits of the same facet of human behaviour (learning), same mode of application (style) and same hypothetical advantage for education. Learning style theories imply the assumption that each person has a specific mode of acquiring knowledge. According to Schmeck (1988:101), "Learning style is a predisposition to adopt a particular learning strategy." Terminology used by Guilford, Thurstone and even Gardner, regarding intelligence, is evident in the formulation of the learning styles in various models (Jordaan and Jordaan, 2000:413–416).

Learning style theories are considered important to unsuccessful learners' education because of the appeal they have on expanding the theoretical foundation of constructivism, adding accommodation of learner differences to the curriculum. They are potentially more practicable theories for fine-tuning the execution of unsuccessful school leavers' education. How learning style theories can contribute to the envisaged education, is the purpose of this part of the study. The focus will be on *learning* with respect to learning styles (*learner attributes)* in the context of unsuccessful school leavers' education.

Learning style models and tests are abundant. Reid (2006:52) mentions 71 learning style models and 70 tests. Considering all 71 models is beyond the scope and purpose of this study. Considering a few learning styles is part of an attempt to establish the best possible unsuccessful school leavers' education for inclusion in the curriculum. A learning style (or styles) may contain valuable attributes. Four of the models, considered prominent, are selected for cogitation. These models and each one's main attributes are listed in Table 4.3:

Table 4.3: Learning style models

FLEMING'S VARK	DAVID KOLB'S MODEL	FELDER AND SILVERMAN'S	GREGORC'S MODEL
Visual	Converger	Active vs. Reflective	Concrete Sequential
Auditory	Diverger	Sensing vs. Intuitive	Concrete Random
"Read/Write"	Assimilator	Visual vs. Verbal	Abstract Sequential
Kinaesthetic	Accommodator	Sequential vs. Global	Abstract Random

(Ouellette, 2000; Coffield, Moseley, Hall and Ecclestone, 2004; Pashler, McDaniel, Rohrer and Bjork, 2009:4 of 26; Rakap, 2010:109).

4.3.2.1 Fleming's VAK (or VARK) Model

Fleming developed a popular learning style model comprising three (four) different styles. It is simple and rather straightforward. The notion is that learners have different preferences for learning, but learning does not necessarily occur through a single sensory mode. Matching teaching and learning styles is presumed to improve learning. The model is divided into the following styles (Rakap, 2010:109):

Visual learners prefer visual exposure to learning content in terms of pictures, charts, slides, graphs, diagrams and models. They purportedly remember what they see better than what they hear and have a good sense of space. Being "outside-the-box thinkers", they allegedly are good at problem solving.

Auditory learners purportedly learn best through verbal lessons, discussions and listening to others. They are sensitive to tone of voice and other nuances to assign meaning to content.

"Read/Write" learners purportedly prefer written content and use writing in rehearsal when studying. They favour lists, headings, notes, essays and books.

Kinaesthetic learners purportedly prefer hands-on approaches. They favour active exploration, experiencing, touch, handling of material/models and performing tasks – learning by doing.

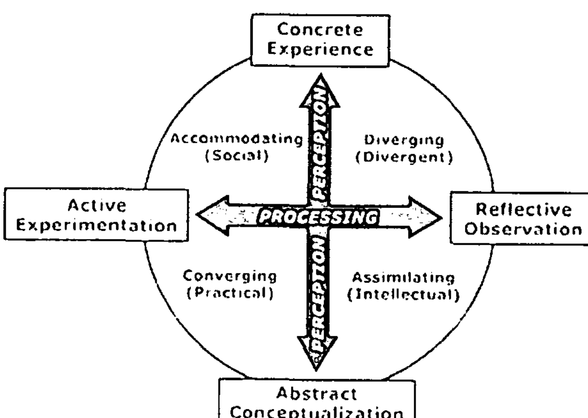
To accommodate all the different learning styles in a classroom will result in a multi-sensory experience (tutorial and learning), a notion recommended and practised by a number of educational approaches, e.g. transdisciplinary, project/problem-based, holistic education, OBE.

4.3.2.2 David Kolb's Model of Learning Styles

Kolb based his model of learning styles on his Experiential Learning Theory (ELT) comprising concrete experience, abstract conceptualisation, reflective observation and active experimentation learning modes (Cooper, 2009). His notion is that all four of these ELT modes should be engaged for accomplishment of the ideal learning process. He formulated four learning styles related to the four learning modes of his theory. The ELT posits that learning is a two-step process of inputting information and processing information. Inputting information, imagined to be on a vertical continuum, from concrete experience at one pole (the top) to abstract conceptualisation at the other pole (the bottom). People's preferences for the first step, inputting information, is thought to be somewhere along this continuum.

The second step, processing of information, is along a horizontal continuum from active experimentation at the one pole (end) to reflective observation at the other. A person's learning style can be located in an area circumscribed by these four extremes (modes). The precise location is determined by the relevance/association with the four modes (Yilmaz-Soylu and Akkoyunlu, 2002:44; Little, 2004:8; Atherton, 2010).

Figure 4.1: Experiential Learning Theory Diagram

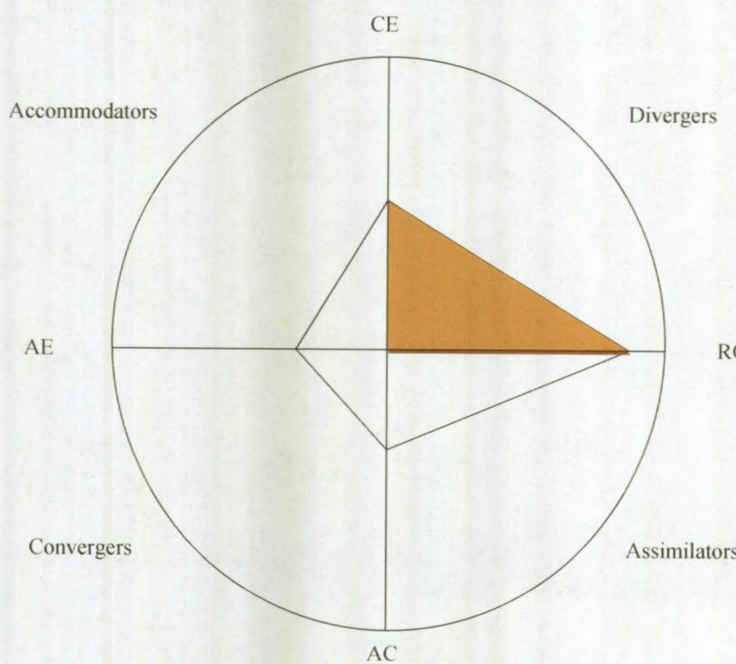


Experiential Learning Theory, from Kolb, Boyatzis and Mainemelis, (1999).

A Learning Style Inventory (LSI) can be used to determine a person's learning style by plotting his/her scores on a learning styles diagram circumscribed by the two pairs of "polar opposites": Concrete Experience (CE) vs. Abstract Conceptualisation (AC) and Active Experimentation (AE) vs. Reflective Observation (RO) (Yilmaz-Soylu and Akkoyunlu, 2002:44). By joining the points, four triangles are formed with the two axes – CE/AC and AE/RO (Figure 4.2). The biggest triangle represents the person's learning style (Kolb, 1984:67–76).

Two reasons are given for calling this perspective on learning "experiential": to tie it to its intellectual origins and because of the central role of experience in the learning process. "This differentiates experiential learning theory from rationalist and other cognitive theories of learning that tend to give primary emphasis to acquisition, manipulation, and recall of abstract symbols and from behavioural learning theories that deny any role for consciousness and subjective experience in the learning process" (Kolb, 1984:20). The intention was to combine experience, perception, cognition and behaviour in a holistic integrative perspective on learning.

Figure 4.2: Learning styles diagram 2



Kolb (1984:67–76).

Only the four ultimate learning styles, represented by the four quadrants in the space bounded by the learning modes, with concrete experience to abstract conceptualisation on the CE/AC and active experimentation to reflective observation on the AE/RO –axis, are briefly described, negating the attributes of a Cartesian plain (Yilmaz-Soylu and Akkoyunlu, 2002:44; Little, 2004:8):

Divergers are purportedly learning by *concrete experiences* and *reflective observation* (Figure 4.2). They are imaginative thinkers favouring their own experiences and seeing things from different perspectives. Being good listeners and reflectors, they like social interaction, discussion and group work.

Assimilators are purportedly abstract, analytical, logical learners and characteristically *abstract conceptual* and *reflective observers.* They seem to be good at creating theoretical models, enjoying thinking them through. Didactic teaching is allegedly their favourite method.

Convergers are purportedly learning by *abstract conceptualisation* and *active experimentation.* Deductive reasoning and practical application seems to be their preferred modus operandi. They like to experience for themselves and therefore will fiddle around with things.

Accommodators purportedly prefer *concrete experiences* and *active experimentation.* They seem to favour learning by doing, studying and rather experiencing by trial and error.

A learner's positions on the inputting (apprehension – comprehension) and processing (intention – extension) continua produce triangles in four quadrants signifying his/her learning style. Learning environments and presentations, favouring the specific learning style, are supposed to improve learning.

4.3.2.3 Comparison of experiential learning theory with psychological learning theories

Although Kolb links his ELT with Dewey's, Lewin's and Piaget's theories, he wishes to distinguish ELT from cognitive and behavioural learning theories. Parallels drawn with Piaget's "processes of experiential learning" are problematic because these are developmental stages of infants and children (Kolb, 1984:23–25, 40). Although there are corresponding aspects, the intentions of the modes are different. Piaget used them to signify developmental stages and Kolb as indication of learning modes and styles.

Kolb (1984:40) describes the basic structure of ELT as "a four stage cycle involving four adaptive learning modes – concrete experience, reflective observation, abstract conceptualisation and active experimentation." It is divided into two "dimensions", (two steps) "each representing two dialectically opposed adaptive orientations" with the learning process within the "transactions among these modes." The concrete/abstract dialectic is one of "prehension" or grasping (inputting information) and the active/reflective dialectic is one of "transformation" (processing information). These two "dimensions" of learning find functional procedural application through the modes described below (Kolb, 1984:41).

Concrete experience is attained through "tangible, felt qualities of immediate experience", a process Kolb (1984) called "apprehension." Learners learn by handling, touching and doing – they physically experience (concrete?) objects (Yilmaz-Soylu and Akkoyunlu, 2002:45).

Kolb's (1984:43) explanation of apprehension as a state of being aware of the surroundings without focusing on them, is a matter of perceiver's attention. Focusing attention on the object or element relevant to the learning opportunity constitutes positive observation, which can be anywhere on the continuum of *prehension*. Some observers will have a *concrete experience* in various degrees and other will have *abstract conceptualisation* assigning more meaning to the object or element.

In constructivism, the same situation will be described differently concentrating on attention and influences on attention (cf. 4.2.2.2.11). The term "concrete experience" resembles the physical handling of the object. "They (learning modes) don't seem to be very accurate descriptions and may even be misleading" (Arthur, 2008:1 of 4).

Abstract conceptualisation is attained through "conceptual interpretation and symbolic representation" called "comprehension". This presumes mental activities on a higher level than concrete experience. Being bombarded by an "*unpredictable flow of apprehended sensations*", order is introduced by *comprehension* – deeper mental processing of the "sensations". In cognitivism the mental process of monitoring, described in par 4.2.2.2.1, handles the abundance of sensory stimuli by giving precedence to familiar, significant and relevant information for further processing. Comprehension, in constructivist terms, is an attribute of the processes of cognition (cf. 4.2.2.2.12).

Reflective observation is "figurative representation of experience" through internal reflection, a process called "intention". Intention is abstract mental "handling" and manipulation of content or information (knowledge) applicable to both concrete apprehension and symbolic comprehension (Kolb, 1984:51, 52). Obviously mental manipulation of concrete apprehension will be on a lower level of mental activity than mental manipulation of symbolic comprehension.

In constructivism, mental manipulation of images (mental rotation) describes the imaginary handling of objects in "three-dimensional space" as if in reality (Sternberg, 2003:225). Mental manipulation of knowledge, images and concepts in sequences of actions or conduct is accounted for in mental scripts and imagination.

Active experimentation is a process of "external manipulation" of objects called "extension". Extension refers to physical handling and manipulation of the object or element. External manipulation of abstract comprehension is a little more complicated because the symbolic representation should be represented (transformed) into physical format, e.g. written, sketched. Apprehension is described by Kolb (1984) as concrete experience attained through "tangible, felt qualities of immediate experience" and explains it as a state of being aware of the surroundings without focussing on it. Learners learn by handling, touching and doing.

This notion of "extension" resembles procedural knowledge in constructivist learning theory. "External manipulation of abstract comprehension" is impossible because it does not physically exist. "Transforming it into physical format" deprives it of its abstract notation. Manipulation of objects remains in concrete domain and also involves procedural knowledge.

Experience, in terms of ELT, is the holistic occurrence of these processes in individual-specific sequences encountered by each learner/student (Kolb, 1984:52). It denotes sensory observation, mental perception, mental transformation and physical response (doing). Experience in constructivist terms comprises perceptual, cognitive, emotive, dispositional and self-processes (Jordaan and Jordaan, 2000:279–284).

Constructivist learning theories account comprehensively for human learning. Upon these fundamentals, educators can construct learning opportunities for effective learning. Learner differences can be accommodated in unsuccessful school leavers' education through diverging expansion of learning in and from the practica, allowing development up to accomplishment of target, leaner satisfaction or full potential. Aligning this differentiation with Bloom's revised taxonomy can facilitate distinctive educational diversity and assessment criteria.

Experiential Learning Theory attempts to account for learner diversity by adapting learning environments and presentations to learning styles, which is impractical and virtually impossible. Yilmaz-Soylu and Akkoyunlu (2002:49) conclude that "learning styles do not have effects on the achievement of students in different learning environments." It may therefore be concluded that other factors are more significant in improved learner achievements.

It is not clear where learning goals, purposes, intentions, choices, decision-making and learning by insight fit into the ELT learning cycle (Kelly, 1997:4 of 5). "The structural base of the learning process", lying in the "transactions among these four adaptive modes and the way in which the adaptive dialectics get resolved" led inevitably to the following: "The structural model of the learning process described in the last chapter is a complex one, capable of producing a rich variety of learning processes that vary widely in subtlety and complexity" (Kolb, 1984:40, 41, 61). The fundamentals of the processes of learning at the heart of constructivist learning theory could not be matched by ELT.

The cyclic feature assigned to ELT poses another problem. The initial two-step process comprises continua on "inputting information" and "processing information", implying individuals in different positions along both, represented by coordinates in the four quadrants representing learning styles. To bring a coordinate (disposition) into the cycle, following a personal preference, results in a complex cycle different from the original diagram cycle and each student has his own preferences. The resulting conglomeration of complex cycles renders effective education, based on real environmentally orientated ELT (meshing learning and teaching styles/learning environments), virtually impossible (Smith, 2001:5 of 8).

4.3.2.4 Felder and Silverman's Learning Style Model

"Students have different strengths and preferences in the ways they take in and process information – which is to say, they have different learning styles" (Felder and Spurlin, 2005:103). Based on this "definition", Felder and Silverman developed a learning style model for traditional learning comprising four dimensions of learning modes. Each dimension spans the continuum from one extreme to the other. Learners purportedly have the following learning styles (Felder and Spurlin, 2005; Graf, Viola, Leo, and Kinshuk, 2007:81, 82):

Active-reflective: At the one end of this continuum are the active learners with preference for physical experiments, manipulation of objects and learning by trying. On the other end are the reflective learners with preference for deliberation, analysis and evaluation of options.

Sensing-intuitive: On the sensory side of this continuum, the learners prefer concrete practical and procedural information. On the opposite side, the intuitive learners prefer conceptual, innovative and theoretical information striving to assign meaning to learning content.

Visual-verbal: Visual learners prefer pictures, charts, slides, graphs, diagrams and models for information collection. Visual representations of learning content afford them learning by visual observation. Verbal learners prefer to hear or read information. It is often better to read out loud to hear the information simultaneously.

Sequential-global: Sequential learners prefer linear succession of orderly arranged information. By assembling the detail, they try to make sense of the whole. Global learners prefer to work from the whole to the detail, making sense of the whole/general before filling in the particulars.

Learning style assessments are done on learners' reflections on what they perceive as their learning strengths and preferences. What seems to be lacking, is investigation that does not rely so heavily on subjects' own perceptions. Cognitive psychologists utilise numerous objective tests to verify their hypotheses and theories leading to the formulation and further development of correlating consistent learning theories.

Learning styles are not innate, fixed or invariable. Felder and Spurlin (2005:105) admit that learning style preferences can be affected by educational experiences. By implication, these learning style assessments should be done frequently to keep up with learner development. Learning preferences are based on familiarity, significance and relevance, which continuously change with cognitive development.

Felder and Spurlin (2005) report on response data for the Index of Learning Styles (ILS) collected in a number of studies done in American universities. The data of a study done at Iowa State University is summarised in Table 1 of their article, but not included in this study. "Of the 129 undergraduate engineering students who completed the ILS in a study conducted at Iowa State University, 63% were classified as active learners (and by implication 37% were classified as reflective learners), 67% were sensing learners (so 33% were intuitive learners) and so on" (Felder and Spurlin, 2005:105). The table is therefore a summary of the occurrences of certain responses on certain questions, but the assumptions made are not tabulated.

The reliability and validity of ILS scores were tested in test-retest reliability measurements, which are reported in Table 4.4 (their Table 3*) (Felder and Spurlin, 2005:107). These tests are evidence of the reliability and validity of the instruments and not directly of the identified learning styles. They do not substantiate or validate the authenticity of learning styles *per se* and therefore do not add to the credibility of the theory(ies).

Table 4.4. Test-Retest Correlation Coefficients

Δt	A-R	S-N	Vs-Vb	Sq-G	N	Reference
4 wk.	0.804					
7 mo.						
8 mo.						

$^{*}p < .05$ $^{**}p < .01$. (Felder and Spurlin, 2005:107, (Table 3*)).

Construct validity is verified with student "profiles" based on their learning styles and confirmed in the reliability and validity tests (Felder and Spurlin, 2005:108). No psychometric tests were utilised to verify or substantiate any of the findings – neither for the learning styles nor for the construct validation.

Research, verifying the authenticity of students' perceptions of their learning strengths and preferences (learning styles) could add scientific value to the theory. With the identified learning styles (dimensions) as independent variables, further tests with different dependent variables could confirm/substantiate the authenticity of the learning styles.

"Learning styles reflect preferences and tendencies; they are not infallible indicators of strengths or weaknesses in either the preferred or less preferred categories of a dimension" (Felder and Spurlin, 2005:110). They are not predictors of learner performance.

4.3.2.5 Anthony Gregorc's model

Gregorc's model comprises two perceptual attributes: concrete and abstract, and two organisational attributes: sequential and random. This model is based on people's perceptions as reference to evaluate their environments (world) and make sense of their observations. These perceptions are the bases for the purported learning styles (preferences) of individuals.

Concrete, as a perceptual attribute, enables registering (observing) information from the environment through the five sensory organs. The abstract perceptual attribute is described as the ability to visualise, imagine, understand and believe, also utilising intuition – basically *cognitive processes*. All people use both concrete and abstract, but not to the same extent and according to a person's own strength, be it concrete or abstract. The organisational attributes, sequential and random, refer to the ability of people to organise observed information, linear ordered or randomly in chunks. Both are simultaneously utilised by people, but dominance depends on the perceiver's strengths (Ouellette, 2000:3). The four "ultimate types" of Gregorc's theory are the following:

Concrete sequential learners prefer a systematic, logical sequence of information, experienced through the senses. Hands-on activities, step-by-step and real life experiences within a structured environment are their favourite learning opportunities.

Concrete random learners are intuitive experimenters who appreciate stimulating environments allowing independent problem solving. They are comfortable with trial-and-error methods in search of solutions to the challenges they are facing and randomly ordered chunks of information.

Abstract sequential learners are individualistic personalities appreciating logical sequences, stimulating opportunities for analysis. They prefer logical, written, verbal and visual instructions.

Abstract random learners are social, interactive and emotional personalities, appreciating direct tuition and healthy relationships. They prefer visual instruction (tuition), evaluating personal experiences and time for reflection. They are comfortable with broad or general guidelines and group work (Hermes, 2010).

These learning styles presumably, are the guidelines for educators to adapt their teaching style accordingly for improved learning. There are, however, doubts about the feasibility and credibility of the assumption (cf. 4.3.2.6).

4.3.2.6 Learning styles review

There is the notion that adapting teaching style to learning styles is virtually implementing multi-sensory teaching-learning experiences. Pashler, McDaniel, Rohrer and Bjork (2009:3, 4) assert, "Why then spend time and valuable resources on expensive, time-consuming learning-style test instruments and tests?" It is, however, difficult to come to a conclusion about the value and place of learning styles in the envisaged education for unsuccessful school leavers before they were evaluated. Further elaboration is therefore necessary.

A number of concerns, originating from the overview, need to be clarified before a final conclusion can be made. Evans, Cools and Charlesworth (2010:468) posit that learning styles and multiple intelligences highlight individual differences and thereby contribute to learner-centeredness in education, but confirmation that they are the most effective ways of dealing with learner differences needs to be established.

How do learners learn? The concern is to determine whether learning styles provide a psychologically legitimate answer or answers to this crucial question adding significant value to the fundamental learning theory, constructivism. Do different learning style theories/models consistently provide the same answer or answers to this basic question? Based on the learning styles, the proponents of these theories posit that learning can be improved by matching teaching style and strategy with learning styles – meshing teaching style and learning styles. The question is whether this meshing hypothesis is validated on proven scientific grounds.

4.3.2.7 Learning style hypothesis overview

Learning style theories have a multitude of learning styles formulated by different theorists in 71 different models. Despite the collective classification of these theories/models, they seem to lack inter-theory correlation and consistency (Cassidy, 2004:440). The abundance of learning style theories/models and their diversity contribute to confusion. Educators have to determine which of the 71 theories, each with its own set of dimensions/styles/categories, provide credible, valid answer(s) to the question of how learners learn. A list of 33 dichotomies, recorded by Coffield et al (2004:136), confirms the conceptual confusion and disarray in the field of learning style theories. A lack of consensus, perplexing terminology, confusing instruments and vague practical implications further demolish the credibility of learning styles (Graf et al, 2007:81; Evans et al, 2010:469).

The field of learning styles "is characterised by considerable conceptual confusion and the lack of any generally accepted definition of what 'styles' may be" (Scott, 2010:6). A fragmented and disparate field offers an array of insignificant, psychometrically unfounded attributes in a multitude of test instruments. Scott (2010:6) further reports that Ferrell (1983:33), in one of the "rare attempts to discover commonality", concluded that different test instruments do not measure the same thing.

In a study on the effect of learning styles on student achievement in different learning environments, Yilmaz-Soylu and Akkoyunlu (2002) use Kolb's learning style model. They found that different learning styles do not influence achievement of students in different learning environments (Yilmaz-Soylu and Akkoyunlu, 2002:49). This research conclusion is supported by Martin (2010).

Although the classification structures used by Kolb (LSI-2) and Honey and Mumford (Learning Styles Questionnaire (LSQ)) use similar descriptors for their classification, Martin (2010:1584–1585) could not find common meaning across measures of these two instruments. The classifications, based on the learning style questionnaires/tests, of the learners were different. "No systematic or statistically significant correlation between the outputs from these instruments was found, and there is a lack of construct validity for either instrument" (Martin, 2010:1586). David Kolb agrees that matching learning and teaching styles is a waste of time (Cosh, 2010).

Kolb himself revealed the greatest limitation of LSI: "The results are based solely on the way learners rate themselves" (Kelly, 1997:4 of 5). LSI lacks psychological research other than self-rating to construct tests for determining learning styles. Tests, independent of student/learner self-judgement, could verify and confirm or contradict LSI test results. Other factors, favouring improved effective learning, should have been taken into account in research regarding the influences of meshing teaching and learning styles – comparing it with LSI.

Learning style theories lack an authentic psychological foundation confirmed by psychometric tests (Coffield et al, 2004:140; O'Grady, 2009; Evans et al, 2010:470). People do not learn differently in the ways the learning-style proponents assert. There is a theoretical incoherence in the field of learning styles. Coffield et al (2004:136) comment that developmental or longitudinal studies of learning styles with a biological or neuropsychological focus could not be found. This remark underscores Reiner and Willingham's (2010:33) refutation of any proof for the existence of learning styles. Theories of learning styles are ***beliefs*** that people have preferences and that people differ and nothing more (Cosh, 2010). "We have found the field to be much more extensive, opaque, contradictory and controversial than we thought at the start of the research process" (Coffield et al, 2004:2).

Furthermore, Cassidy (2004: 431) reports that despite studies showing support for Kolb's style outlines to be associated with students' performances, "studies examining the psychometric properties of the LSI have raised concerns about its reliability and validity."

Learning style theories suggest differences in preferred learning modes distinct from ability and independent of learning content. A learning style is supposed to be a ***specific ability*** or a ***specific aptitude*** (Reiner, 2010:1 of 4). It is difficult to identify preferences that are independent of cognitive ability in general (or being a *specific ability*) and even trickier to find preferences that are independent of content. Preferences are dominated by learners' cognitive ability, popularity of content and presentation popularity.

Learning styles (***specific abilities/aptitudes***) as described by theorists are insignificantly related to specific aptitude profiles. There is no doubt that aptitude and ability differences exist, but to conclude that they are so significant and specific that they can be identified as different learning styles, is beyond any scientific proof. Pashler et al (2009:9) conclude, "[E]vidence for specific aptitudes does not, by itself, validate the learning style hypothesis."

The learning ability and preferences will change with cognitive development of the learner. Pashler et al (2009:5) report, "McNamara, Kintsch, Butler-Songer and Kintsch (1996) demonstrated that the conditions of instruction that are optimal differ depending on student's prior knowledge." Learning style theories are found to be confusing, do not influence achievement of students, do not have common meaning across measures (learning style tests), lack psychological research and an authentic psychological foundation, lack psychometric properties putting reliability and validity in question, do not comply to the criteria of a specific ability and are not related to a specific aptitude profile. Learning style theories do not provide scientific evidence to substantiate the existence of learning style as an independent psychological ability.

4.3.2.8 Learning and teaching styles meshing hypothesis review

The meshing hypothesis is the assumption that learning can be improved by matching teaching styles and methods with learning styles, i.e. visual learners will learn more effectively when material is presented visually. Application of learning style theories presumes selection of teaching style and strategies on account of learning style(s) of learners (Reiner and Willingham, 2010:34).

Proponents of the meshing hypothesis maintain that matching teaching style and methods with learning style improves learning. Contrary to that, cognitive psychologists denounce the notion and conclude that learning preferences do not make any difference in the effectiveness of learning. "Matched" teaching and learning styles do not result in learning that is more effective. Willingham (2006:4), after extensive studies, came to the conclusion that matching instructional modality and learning styles has yielded no positive educational effect. Learner preferences for specific learning styles have minimal implications for educational practices and policies (Pashler et al, 2009:6). Learning style theorists fail to prove that learning can be improved by matching teaching mode to learning style.

Matching teaching mode to a specific learning style does not demonstrate any contribution in providing effective teaching. Pashler et al (2009:11), in their evaluation of several potentially valid studies, report: "These negative results, in conjunction with the virtual absence of positive findings, lead us to conclude that any application of learning styles in classrooms is unwarranted." Reiner and Willingham (2010:33) further comment that useful content in learning style theories is contained in other educational approaches, denouncing the significance of learning styles. Teaching method is more relevant to learning content than learning style. It is a better option to adapt teaching mode to learning content.

The specific type of interaction between assessment of a learner's learning style and the instructional method needs to be documented. Formulation of the interaction, exceeding straight forward linking, should be fundamental to the instructional strategy matching a specific learning style. "Basically, evidence for a learning-styles intervention needs to consist of finding that a given student's learning is enhanced by instruction that is tailored in some way to that student's learning style" (Pashler et al, 2009:5).

From Martin's (2010) article it is concluded that implementation of learning style theories in highly effective United Kingdom schools is compulsory "window dressing." Teachers are "unperturbed" by the lack of reliability and validity of learning styles theories, and failure of the learning style instruments is not regarded a matter of great importance (Martin, 2010:1587).

Practical application of these theories is not very meticulous (Martin, 2010:1589).

Pashler et al (2009:6) set criteria for establishing credibility and validity of learning styles. These criteria could just as well be used to test the meshing hypothesis. Two or more groups of learners should be divided into their "authentic" learning styles. Each learning style group should be randomly assigned to different learning methods. All the learners should be given the same test of achievement. The test results should reveal that the learning method that optimises test performance of one learning-style group is different from the learning method that optimises the test performance of the other learning-style group.

On the proposed graphs, the learning style groups should be the independent variables and the test scores the dependent variables with the learning methods the functions. The learning method that optimises test scores of one group should be different from the learning method that optimises the test scores of the other group. If the coordinates on the graph are connected by straight lines, they should intersect. Such a finding would prove learning styles valid (Pashler et al, 2009:7, 8). Selecting matching teaching methods for the identified learning styles would establish evidence for or against the meshing hypothesis. It would, at the same time, prove learning styles independent from cognitive ability, i.e. it would prove the existence of specific learning aptitudes.

Otherwise, superiority of learning method could be established by making the methods the independent variables and the learning styles, the functions. If one learning method outscores the other in both groups of learners, that method would be proved superior refuting the theory of learning styles.

"It should also be noted that even if the evidence had convincingly documented style-by-method interactions – which we have concluded is scarcely the case – the interactions would need to be large and robust, and not just statistically significant, before the concomitant educational interventions could be recommended as cost-effective" (Pashler et al, 2009:16).

Justification for the utilisation of meshing teaching and learning styles, except in terms of "face value," could not be found. English teachers couldn't care less about validity and reliability (Martin, 2010:1588). If the evidence to support the learning style hypothesis is insufficient, the meshing of teaching and learning styles hypothesis cannot be supported either because the independent variable (learning style) is insignificant. Both hypotheses are proven null and void. Further discussion of learner differences accommodation will focus on multiple intelligences, formulated by Howard Gardner.

4.3.3 MULTIPLE INTELLIGENCES THEORY OF HOWARD GARDNER

Multiple intelligences is an account of the diversity of human intelligence, dividing human "cognitive" potential into eight different "intelligences" (potentials) (Snowman and McCown, 2011:115). The theory is based on neuropsychological research and the notion of "a series of relative separate faculties" of the human mind (Gardner, 1999:32). Gardner (1999:33, 34) decided to use the term "intelligence" instead of abilities, talents or gifts because these terms "harboured pitfalls" and "would not have attracted much attention."

Gardner (1999:83) refutes any notion that multiple intelligences are the same as learning styles, cognitive styles or working styles. Labels and descriptions may have contributed to possible unjustified connotations, e.g. linguistic intelligence, auditory (verbal) learning style and bodily-kinaesthetic intelligence vs. kinaesthetic learning style.

An overview of "multiple intelligences" is considered necessary because of the appeal that acknowledgement of different modes of intelligence and aptitudes, mainly inherited ability, has on the aspect of accommodating learner differences in education for learners who do not respond well and progress in the mainstream school system with its linguistic-logic-mathematical predilection. The significance "multiple intelligences" may have for unsuccessful school leavers' education will be investigated.

4.3.3.1 Overview of multiple intelligences

A few definitions of "intelligence" can distinguish it from the lay meaning of a position on a continuum of human mental capacity with "intelligent" at the upper end and "unintelligent" on the other. There are a number of definitions for intelligence in the literature:

- "The **ability** to (a) effectively handle and apply abstract concepts, (b) to recognise relationships and learn new subject matter and (c) adapt effectively to new circumstances or situations" (Plug, Meyer, Louw and Gouws, 1993:159).
- "Intelligence is the **capacity** to learn from experience, using metacognitive processes to enhance learning and the ability to adapt to surrounding environment, which may require different adaptations within different social and cultural contexts" (Sternberg, 2003:485).
- "The **capacity** for understanding; **ability** to perceive and comprehend meaning" (Butterfield et al, 2003:844).
- Gardner (1999:33) defines intelligence as "biopsychological **potential** to process information that can be activated in a cultural setting to solve problems or create products

that are of value in a culture."

Gardner added practical application to the notion of potential in his definition of intelligence. His definition is a combination of mental potential and aptitude. It is, however, selectively applied considering the limited number of "multiple intelligences." Contrary to Gardner's definition, intelligence is regarded as a mental capacity with a single underlying ability, general intelligence (g), denoting the power (signifying *complexity*) and speed (*sharp-witted*) with which linguistic-logic tasks can be executed (Jordaan and Jordaan, 2000:402, 411; Willingham 2004:1 of 8; Louw et al, 2008:326).

Intelligence is partially inherited and partially the result of environmental influences (Jordaan and Jordaan, 2000:418–421). Environmental influences on intelligence cause it to be an *ability*, which can be developed contrary to *potential*, which is inactive. Considering intelligence a potential renders it 100% inherited possibility, not yet actual. This potential would not be measurable. A compromise approach to inborn and environmental influences on intelligence posits that inherited potential provides the possibility for environmental factors to activate the potential (Jordaan and Jordaan, 2000:421, 422). To what extent – how close to the ceiling of potential – intelligence is developed depends on environmental exposure and stimulation.

Some aspects of intelligence can be measured, however debatable this may be, in terms of intelligence quotient (IQ) (Sternberg, 2003:486–494). Although IQ does not fully represent peoples' intelligence there is correlation between IQ scores and academic performance (Jordaan and Jordaan, 2000:419, 424, 425). It provides some form of prediction of academic success. The correlation is good enough to be valuable in education.

Gardner (1999:41) refutes these notions and formulated seven of the current eight/nine "intelligences" in his book, *Frames of Mind*, in 1983. Later additions (two) are included in this list:

- "**Linguistic intelligence** involves sensitivity to spoken and written language, the ability to learn language and the capacity to use language to accomplish certain goals." This may also be referred to as verbal-linguistic intelligence, and incorporates oral, aural, reading, writing and reasoning skills.
- "**Logical-mathematical intelligence** involves the capacity to analyse problems logically, carry out mathematical operations and investigate issues scientifically."
- "**Musical intelligence** entails skill in the performance, composition and appreciation of

musical patterns."

- "**Bodily-kinaesthetic intelligence** entails the potential of using one's whole body or parts of the body to solve problems or fashion products."
- "**Spatial intelligence** features the potential to recognise and manipulate the patterns of wide space as well as the patterns of more confined areas."
- "**Interpersonal intelligence** denotes a person's capacity to understand the intentions, motivations and desires of other people and consequently, to work effectively with others."
- "**Intrapersonal intelligence** involves the capacity to understand oneself, to have an effective working model of oneself – including one's own desires, fears and capacities – and to use such information effectively in regulating one's own life" (Gardner, 1999:41–43).
- "**Naturalistic intelligence** refers to the ability to recognize and classify plants, minerals, and animals, including rocks and grass and all variety of flora and fauna. The ability to recognize cultural artefacts like cars or sneakers may also depend on the naturalist intelligence" (Guignon, 1998).
- **Existential intelligence:** "To be concerned with "ultimate" issues of life and to engage in transcendental concerns. The capacity to locate oneself with respect to the furthest reaches of the cosmos – the infinite no less than the infinitesimal – and the related capacity to locate oneself with respect to the most existential features of the human condition – the significance of life, the meaning of death, the ultimate fate of the physical and the psychological worlds, such profound experiences as love of another human being or total immersion in a work of art" (Shearer, 2005:27). Gardner (1999:66) did not add this "intelligence" to his list, because it did not fully satisfy two of the criteria: *cerebral specification* and *clearly defined cognitive components.*

Gardner (1993:35, 36) objected to the exclusion of at least five of the seven (or seven of the eight/nine) "multiple intelligences" from IQ tests (Jordaan and Jordaan, 2000:402, 403). According to him, they should all be equal, which suggests that they should be included in the psychometric (IQ) tests. IQ is not an intelligence score *per se.* It is only some measure of the power and speed at which individuals perform in test situations in linguistic and problem solving ability. Including the remaining "multiple intelligences" in IQ tests, will be equivalent to combining IQ and aptitude tests, considering the definitions of the other "intelligences." Human functioning is complex, but education needs predictors of academic and perceptual-motor performance for early identification of strengths and weaknesses of learners. That could help in avoiding school dropout and improve career guidance.

It must be noted that after 27 years Gardner and the proponents of "multiple intelligences" have not come up with psychometric tests for "multiple intelligences" other than objecting to the exclusion of five/seven of the multiple intelligences from psychometric tests. Available "multiple intelligences" tests are mere questionnaires to determine "intelligence" type (Chislett and Chapman, 2005). They do not measure dimension/magnitude of cognitive capacity or "intelligence scale" – how clever learners are in specific "intelligences." Besides classification of learners in different "intelligences", no indication can be given of the scale of those "intelligences." Louw et al (2008:333) discuss only IQ tests and Kumbar (2006:4) confirms the absence of psychometric tests for multiple intelligences up to publication of his article. Test instruments that can identify and predict learners' performances in specific educational fields and occupations, would be more than welcome.

Talking about "multiple intelligences" is also an effort to accentuate learner differences, which should be considered in education (Gardner, 1993:66). Furthermore, Gardner (1993:231) endeavours to explain the "diverse manifestations" of intelligence within and across cultures, assuming that intelligence is something different in different cultures. Establishing a theory of intelligence that spans the range of cultures posits a concept equally valid across cultural boundaries, meaning the same thing in all cultures (Gardner, 1993:232). Including cultural influences, as indicated in Gardner's definition of intelligence, will complicate the formulation of the theory and proposed assessment instruments.

Throughout the study of "multiple intelligences", it is clear that the term "intelligence" does not have the same meaning for proponents and opponents of the theory. Proponents of "multiple intelligences" consider aptitudes, talents, and perceptual-motor abilities, matching Gardner's criteria, "intelligences" and disparage the concept of general intelligence (g). Opponents consider intelligence as a multifaceted cognitive capacity with a hierarchical structure (Willingham 2004:1 of 8).

The concept of "multiple intelligences" and its contribution to education should be proven beyond any doubt before it can be considered a premise in unsuccessful school leavers' education. The abilities of learners in all these "intelligences" should be psychometrically measurable according to specific scales to justify accommodation of learners accordingly. Utilising aptitude tests to determine the strengths of learners in each of these "intelligences" would be refutation of the theory of multiple intelligences – acknowledgement that they are actually aptitudes.

4.3.3.2 Multiple intelligences evaluation

The theory of multiple intelligences is controversial. It cannot be accepted unconditionally for inclusion in the theoretical framework of unsuccessful school leavers' education. A fundamental issue is the different concepts of intelligence and the status of general intelligence. Whether some aptitudes, talents, and perceptual-motor abilities (eight/nine "intelligences") can be promoted to the rank of intelligence, is a concern because it is accompanied by the denunciation of general intelligence (g).

"Multiple intelligences" is a movement away from the concept of cognition and inclusion of other facets of human ability into the mental sphere (Peariso, 2008:4). General intelligence (g) is more than a theory and is supported by empirical research and 100 years of data, which consistently show correlation of performances on intellectual tasks (Willingham, 2004:4 of 8). The theory of "multiple intelligences" does not account for the correlation in the data. Gardner (1993:39) does not deny the existence of g, but the theory of "multiple intelligences" is not reconcilable with the theory of general intelligence (Jordaan and Jordaan, 2000:411). It is a superficial concept of intelligence, with poor differentiation between mental and other abilities.

"Multiple intelligences" are not empirically tested to prove that they are indeed autonomous mental faculties, contrary to central processing accounted for in a single underlying ability, called general intelligence (g) (Peariso, 2008:6). The theory was not thoroughly subjected to in-depth quantitative inquiry. Proponents and "conformists"/sympathisers prefer qualitative/interpretative methodology. "Gardner's theory of mental abilities remains aloof from research based on measurement and analysis in the tradition of the natural sciences" (Jensen, 2007).

Gardner's criteria for identifying "intelligences" lose their rigour by accepting a majority of criteria as sufficient and ignoring to a large extent the most rigorous, psychometric criterion (Willingham, 2004:4 of 8). That leaves the door open for enthusiastic researchers to "discover" new intelligences. *Humour, memory, olfactory, spelling, near-space and far-space* are mentioned by Willingham, (2004:4 ,5 of 8) as strong contenders because they meet the minimum (Gardner's) criteria to be assigned the status of "intelligence".

The fundamental flaw in the theory of "multiple intelligences" is the assumption that the mind is a confederation of largely independent, self-sufficient processes and ignoring its interconnected, interactive complexity. Each of the "multiple intelligences" needs a number of cognitive processes of which only one or a limited number are "intelligence-specific". Damage to part of the brain supporting an "intelligence-specific" process will compromise that "intelligence" leaving other "intelligences" virtually intact. By this over-simplified notion of neurophysiologic evidence, a criterion is easily met, but other processes generic to more "intelligences" denote overlapping brain faculty functions (cf. general intelligence). The psychometric criterion, routinely ignored by Gardner, is the most suitable to determine independence of processes underlying an "intelligence" (Willingham, 2004:5, 6 of 8).

"Multiple intelligences" are incorporated into education practice in different ways. Expanding the curriculum into the different "intelligences" – appealing to all of the intelligences – is one model of a "multiple-intelligence" school. Teaching through learners' "intelligences" – using the activities synonymous with the "intelligence" regardless of the topic (using "intelligence-specific" methods and materials) – is another model utilised, but Gardner criticised both. Gardner does not provide a model or framework of "multiple-intelligence" education. His publications "Aims and Means of Education" (1993:187–212) and "Assessment etc." (1999:135–181) are not distinctly "multiple-intelligence" education.

4.3.3.3 Perspective on multiple intelligences

"Multiple intelligences" are primarily inborn potentials (aptitudes), which denote abilities to succeed in related functions (Gardner, 1999:33). Aptitude is mainly an inherited ability to perform a specific activity or acquire a specific skill (Plug et al, 1993). Excellence in performing a specific task (mental, physical or artistic), in this regard, can be described as a talent. Although intelligence can be a talent, it is more mentally orientated; aptitude is more of an ability/talent, which sometimes does not require profound mental capacity (intelligence).

Intelligence and aptitude are sometimes regarded in some ways as opposite: a very good rugby player may be seen as highly talented, while an academic intellectual may be regarded as a "nerd." The rugby player does not need to be mentally "strong" and the academic intellectual does not need to be physically strong, but they may be. The rugby player has an aptitude for physical activity ("bodily-kinaesthetic intelligent") and the academic intellectual an aptitude for mental activity. Despite the semantic complexity, intelligence is primarily a mental capacity and aptitude a specific ability that does not necessarily require profound mental ability. Gardner's "multiple intelligences" fit the description of aptitude perfectly (Darius, 2008:2 of 4). This conclusion distinguishes intelligence as primarily a mental capacity in declarative knowledge employment and "multiple intelligences" as a capacity in simultaneous utilisation of declarative and procedural knowledge signifying aptitude.

Gardner (1993:39) rightly comments that there is correlation between IQ scores and school success, but IQ scores are nevertheless poor predictors of career (occupational) success (Jordaan and Jordaan, 2000:413). If IQ scores are associated with high academic achievement but are poor predictors of occupational success, what is the correlation between high academic achievement and success in real life (occupational success)? By implication, school success should not correlate with real life success and high academic achievement cannot predict high real life achievement. Hence the question: do schools sufficiently prepare learners for real life? Career success, however, involves factors not accounted for in IQ or even aptitude tests.

These are issues relevant to the school dropout problem reported in Chapter 1, but themes for other studies. Do these inconsistencies prove the existence of "multiple intelligences" or justify the extension of intelligence measurement to all the "multiple intelligences?" Proponents of "multiple intelligences" should have developed psychometric tests to measure the scale of the "intelligences" and provide performance predictors for education.

Classification of a limited number of aptitudes under specific "intelligences" implies that some abilities are of a higher order than others are. Only "intelligences" are accentuated and therefore get precedence (Gardner, 1993:45). Aptitude should be considered over a wider spectrum of human attributes for educational purposes, but the prime concern should be innovative teaching strategies, appropriate for the learning content, complementing the psychological learning theories (Jensen, 2007). Converting presentation of learning content into techniques favouring the unrelated "strengths/intelligences" of learners – with unproven success – is a daunting task in education.

"Multiple intelligences" differ in concept and definition from the hierarchical model of intelligence. Gardner (1999:33), by changing the concept, but keeping the name intelligence, makes it a controversial theory unacceptable to cognitive scientists. Moving away from the traditional notion of intelligence supposes matching psychometric tests to determine learners' strengths in specific "intelligences", but no tests were developed by Gardner and his collaborators. Without any psychometric tests, performance of learners can hardly be predicted especially if they transfer between institutions. The lack of psychometric tests and scales for evaluation renders "multiple intelligence" identification insignificant.

Primarily two educational models were developed for "multiple-intelligence" implementation, but both are criticised by Gardner. Gardner is also criticised by Willingham (2004:6 of 8), for criticising a specific model of "multiple-intelligence" education and praising the author (Thomas Armstrong) of a book promoting the same model. This inconsistency is beyond explanation. His own educational propositions do not incorporate distinct "multiple intelligence" features.

Besides the oft-mentioned fact that learners differ, "multiple intelligence" theory has no contribution to unsuccessful school leavers' education. Lacking scientific evidence of significant improvement in learner performances, trivial methods and haphazard applications render "multiple intelligences" inappropriate. The exclusion of "multiple intelligences" theory from unsuccessful school leavers' education theory is not based on Gardner's educational notions (Gardner, 1993:187–212; Gardner, 1999:134–181), but on the inappropriateness and impracticality of the theory in this case. Gardner's educational approach and notions, however admirable, appear fairly general in educational literature (cf. Felder and McPhee, 2008, Killen, 2010 and Woolfolk, 2010).

This conclusion also concludes the division on accommodation of learner differences rendering Bloom's revised taxonomy of learning outcomes an appropriate theory for differentiation in unsuccessful school leavers' education. Selection of an educational approach/model appropriately match the theoretical foundation established, is a further consideration.

4.4 CONSIDERATION OF PRESENTATION (TEACHING) STYLES

Knowledge about education (declarative knowledge – knowing that) does not make a good teacher, but procedural knowledge (knowing how), mobilised by intellectual skills (cf. 4.2.3.4), signifies educational capacity (Sims and Sims, 1995:49). Ayers, Sawyer and Dinham (2004:144) in Killen (2010:37) posit "[E]ffective teaching is a matter of 'expertise rather than experience,' " signifying the elements of "quality teaching." Quality teaching (facilitation) is a skill (know how/procedural knowledge) supported by declarative knowledge (subject knowledge and professional knowledge). The concern about teaching style is very much a matter of, *How do you teach?* and, *How should you teach?* Disapproving learning styles and "multiple intelligences" earlier renders the matching of teaching style with these two, superfluous.

Teaching style has not received much attention from scholars and educators, resulting in its very sparse appearance in scientific and educational literature. Evans, Harkins and Young (2008:1 of 6) report limited research on Canadian teachers' teaching styles. "Researchers who have investigated teaching styles have tended to work independently and have developed their own set of indicators for identifying different teaching styles. This has led to a variety of definitions of teaching style and to the development of a number of different dimensions for measuring teaching styles" (Evans et al, 2008:1 of 6).

4.4.1 TEACHING STYLES

In the absence of a consensual definition, it can be said that teaching style is very much a personal trait shaped by education in general and teachers training specifically. Teachers who are teaching like their teachers or mentors did, have missed the essence of teacher training. Teaching style is linked to educational approach (policy), learning content and teaching strategy, which encompasses methods and techniques. Attendant factors, normal ingredients of the learning opportunity recipe, are learners, equipment and facilities. Isolating teaching style from the interrelated, integrated, complex field of education to tailor it for unsuccessful school leavers' education is an endeavour beyond the means and mode of this study. Although personal style is shaped by teacher training a few notions on teaching styles are briefly mentioned.

Killen (2010), Feldman and McPhee (2008) and Swanson and Holton (2009) put emphasis on teaching approaches, strategies, the art and science of teaching rather than differentiating teaching styles. Mishra's (2007:2, 3) approach is a compromise between teaching strategy and teaching style.

4.4.1.1 Features of teaching styles

Educators' reservoir of knowledge must be comprehensive. They should be experts in subject knowledge and well acquainted with relevant real life applications. Educational knowledge, equally important, provides the foundation for educators' teaching practices. How learners learn is an essential aspect of educational knowledge because learning is the goal of teaching – "learning styles" excluded. In addition to the declarative knowledge, they should be well equipped with procedural knowledge – *mobilisation of the declarative knowledge* (cf. 4.2.3.3) – that can only be acquired through application and exercise. These will impact on their teaching style, which they will develop during their teacher training and further in the teaching profession. Teaching style should harmonise – in right and healthy relationship – with a fundamental learning theory, learning content, educational approach, learner level of development and outcomes pursued.

4.4.1.2 Teaching style and learning

The selected teaching style should always be compatible and appropriate for the learning content, aims of learning opportunities and learners (Mishra, 2007:4). Considering learners in the selection of a teaching style is not based on learner preferences because learners are open to teaching styles different from their preferences. Aspects that can perk up the learning experience should get the necessary attention. Learning opportunities need to be discussed with learners in advance. Engaging them in the forthcoming learning opportunity ("planning") will inform them about the prospects, create expectations and prepare their minds (Mishra, 2007:14).

"Differences in teaching styles may also impact on areas such as classroom arrangements, the organization and assessment of activities, teacher interactions with students and pedagogical approaches, such as the use of questioning" (Evans et al, 2008:1 of 6). In conjunction, educators' classroom performance relies on venue preparation, planned presentation, learning activities and approaches to the assessment of learning. Teaching styles are primarily dictated by subject area/field, curriculum initiative of the authorities, teacher-training experience, teaching philosophy and personal preferences.

Teaching strategies should be based on clarity of learning intentions, specifications, success criteria, the power of multiple and appropriate methods and techniques and timely feedback (Killen, 2010: 131; Scott, 2010:7). Empathy with learners, seeing learning opportunities from their perspective, relying on knowledge of strategies (methods, techniques and modalities) is the appropriate propensity for educators.

Job satisfaction, socio-cultural background, attitude and personality traits are influences on classroom atmosphere, which impact on the affective involvement of the learners. These aspects involve the emotional state of mind of the educator and impinge on the mood of the presentation. Teaching style is more complex than reflected in the literature consulted, because the role of personality traits in teaching styles is not well documented.

Teaching style, currently not well researched or defined, is not so much something to match with learning preferences or "multiple intelligences" but a consideration and attribute in learning opportunities. It will feature in the learning opportunity design and presentation. The main concern should therefore be the best possible learning experience for learners.

4.5 EDUCATION APPROACHES/MODELS

"Some knowledge of existing curriculum models is useful, as they may serve as guidelines in curriculum design" (Carl, 2010:106). Determining these guidelines necessitates a review of educational approaches regarded relevant to the educational situation of unsuccessful school leavers.

The fundamental learning theory provides a foundation for unsuccessful school leavers' education to address inadequate learning and the resultant lack of progress. This theory must find active, appropriate application in a suitable curriculum to be conducive to effective learning and education. It can be concluded from Feldman and McPhee (2010:38) that "application" of the fundamental theory, strategies and educational approach should be "apparent." Constructing a curriculum on this foundation necessitates matching the different aspects within a complementary education model. An education model to correspond with educational fundamentals, learner needs and established context focuses the study on competency-based models.

The nature of technical or engineering education at FET colleges is not in question, but their suitability for learners who cannot respond appropriately to school and FET college education in the field of engineering. Technical education (engineering studies) fails to address the major educational obstacles that learners encounter. A different concept for an approach to education, capable of living up to the expectations, is emerging from this study. Being procedural and functional in character, it attempts to circumnavigate the basic educational obstacles facing these learners. Reviewing educational approaches and the current FET college programmes can therefore contribute to a better understanding of the educational situation of unsuccessful school leavers and the obstacles they encountered.

4.5.1 OUTCOMES-BASED EDUCATION (SPADY'S 1994 OBE PHILOSOPHY)

In outcomes-based education, the emphasis is on the consequence (attainment target/end result/what learners are able to do: the outcome) of education, and the learning and exercises (training) to acquire the desired competence. Focusing on "the desired end results and the instructive and learning processes" – the purposes of OBE – is not distinctly a phenomenon of outcomes-based education (Van der Horst and McDonald, 1997:7). In real life situations, on the job training and training for the "job," the focus is on the competency of the trainees. The primary concern of the authorities and employers involved in these training endeavours is what the trainees can do and what they know to enhance their performances (Spady, 1994:4; Spady, 2008).

Even in traditional and vocational education, competence was not overlooked, but in OBE the desired outcomes are more prominently defined. The South African trend in general, revealed in the Curriculum Statements and subject guides, is still towards competency-based education (Department of Education, 2005; Department of Education, 2006; Department of Education, 2006a; Department of Education, 2006b).

According to Killen (2010:52) an outcomes-based approach "places strong emphasis on the total result of the educational process." What learners should be able to do – proficiency of learners – is of paramount importance. It is the proficiency a qualification presumes that has value in the labour market. This proficiency implies accomplishment of the outcomes in the development of whole proficient persons. Spady's 1994 OBE philosophy presumes holistic development of learners ("total result") and development of all learners.

4.5.1.1 OBE pyramid (structure)

The fundamentals of outcomes-based education are defined in the OBE-pyramid consisting of the paradigm, purposes, premises, principles and practices. Elaboration on the building blocks of the pyramid explains the guidelines for successful outcomes-based education (Spady, 1994:8).

The paradigm

"What and whether learners learn are more important than when and how they learn" (Spady, 1994:8). The paradigm of OBE does not imply that time and schedule is ignored completely, but learners are accountable for the ways in which time is spent (Spady, 1994:15, 16). The fact that "accomplishing results" is more important than "providing services" accentuates the desire to improve the learning and competence of the broad spectrum of learners rather than emphasising improving and polishing the quality of educator performance – the focus is on learner performance. Emphasising learner performance also brings the role of the educator into the spotlight. Planning and execution of education will be different due to the greater involvement and extended responsibility of the learners.

Two purposes

Ensuring that all learners are equipped with "knowledge, competence and qualities"[(1)] with the opportunities and equipment to "achieve and maximise" the desired exit outcomes "by all learners and educators" being furnished by schools[(2)], are the two purposes of OBE (Spady, 1994:9).

Three premises

Based on the three premises, or four beliefs as stated by Van der Horst and McDonald (1997:7), it seems likely that wider success in education will be accomplished, especially amongst less prominent achievers.

Outcomes-based education is a learner-centred, results-orientated approach to education, founded on the following underlying premises or beliefs:

- All learners can learn and succeed, but not on the same day in the same way.
- Success breeds success/Successful learning promotes more successful learning.
- The learning environment is responsible for creating and controlling the conditions under which learners can succeed (Closson, 1993; Spady, 1994:9; Van der Horst and McDonald, 1997:7).

- *All individual learners must be allowed to learn to their full potential and all learners must be granted opportunities to reach it.
- *"All the different stakeholders ... share in the responsibility for learning" (Van der Horst and McDonald, 1997:7). (*The last two being added to Spady's list of three premises.*)

The first premise needs further qualification because it has the connotation of equal potential but different rates of accomplishment as if all learners are able to learn the same material, e.g. mathematics, regardless their aptitude and intellect. According to Spady (1994:8) *"It is only a matter of how and when they learn,"* but that is a further negation of intellect and aptitude. All learners can learn but potential limits and different aptitudes cannot be negated (Jordaan and Jordaan, 2000:422). Whether the first premise is true for GET and ABET, is not within the ambit of this study.

Four principles

The four principles, *clarity of focus*, *expanded opportunity*, *high expectations* and *designing down* provide norms for the curriculum, learning opportunities and assessment.

Clarity of focus

Clarity of focus is provided by the desired outcomes, the assessment criteria and range statement as the core work documents for learners and educators alike. Incorporated in unit standards, education standards or curriculum statements, they will guide educators and learners towards the accomplishment of the outcomes and goals. William Spady and Anne Schlebusch (1999:31) state that curriculum planners and educators must have a clear vision of the desired outcomes expected of learners. The focus must be maintained while working with learners and also made clear to the learners. "OBE educators and learners always know what outcomes they are working towards, and why" (Spady and Schlebusch, 1999:31).

Expanded opportunity

Expanded opportunity requires expanded duration, more frequent occurrence and precise timing of learning opportunities. Learners must be allowed access to these opportunities more than once while educators extend learning events with differentiated methods and modalities. Based on the difference in learning styles and rates, it contributes to the premise that all learners can learn and enhances the possibility for all learners (Spady, 1994:12-16).

It can be concluded that "precise timing of learning opportunities" refer to the state of learner knowledge foundation relevant to new material and readiness to learn. This signifies the constructivist idea of prepared minds and relevant existing mental representation. There is also a connotation of unlimited time schedules, which should be considered carefully because it is already difficult, according to the interviewees, to get through programmes like NC(V) with integrated workshop practice and extensive administrative duties. Repeated learning opportunities and extended learning events will put educators' schedule planning to the test.

High expectations

Educators must set high-level performance standards and persuade learners to meet them. Increasing the level of challenges presented to the learners can boost levels of motivation and challenging tasks can inspire high quality performance. Improving the standard of performance will denote improvement in the competency of learners and progress in education. Stimulating the desire for quality output can satisfy the (high) expectations of educators, parents and learners (Spady, 1994:15, 17).

Designing down (back)

Designing down (back) means that the desired exit outcomes must be established first to serve as guidelines for the designing of the curriculum and planning of the learning opportunities, assessment and the record keeping. Outcomes are distinguished as culminating, enabling and discreet outcomes. Discreet outcomes can be eliminated from the curriculum because they are "nice to know" or educator favourites. Enabling outcomes are the "building blocks" of the curriculum culminating into the exit (culminating) outcomes (Spady, 1994:18).

Applying these "power principles" deliberately, consistently, systematically, creatively and simultaneously can facilitate effective and successful education for the vast majority ("all") of learners (Spady and Schlebusch, 1999:30).

Practices

Outcomes-based education, as explained by Spady (1994:1–69), also has a structure which is actually the implementation of the theory – the realisation of the theory. Configuration of the OBE pyramid will be incomplete without these practises or execution plan. Activation of OBE to operational education should be done by implementation of a plan based on this "curriculation" structure.

Designing backwards, the fourth "power principle", actually describes the basic structure of the practices. A system framework, comprising: performance standards and credentials; curriculum content and articulation structure; instructional interaction and technology structure; eligibility; promotion and assignment structure supporting the culminating outcomes, guides the implementation of outcomes-based education (Spady, 1994:22-24). These practices are worth considering in the construction of unsuccessful school leavers education.

4.5.1.2 Components of outcomes-based education in South Africa

Outcomes-based education has three components: fundamental learning, core learning and elective learning (RSA, 1997:60; RSA, 1998a:3, 10). These components are elucidated in RSA (1998a:3, 4):

- "Fundamental learning means that learning which forms the grounding or basis needed to undertake the education, training or further learning required in the obtaining of a qualification."
- "Core learning means that compulsory learning required in situations contextually relevant to the particular qualification."
- "Elective learning means a selection of additional credits at the level of the National Qualifications Framework specified, from which a choice may be made to ensure that the purpose of the qualification is achieved."

Fundamental learning, which is compulsory for all learners to acquire the ability to learn effectively and other life skills, is a compulsory component of OBE. The fields of study include languages and communication, numeric literacy and an optional subject, such as information technology, that can enhance learner ability to operate in the school and real life environments. Two to three subjects may be offered.

Core learning includes two to four subjects directly focusing on accomplishing the desired competence for the particular qualification or occupation. It also makes provision for practical applications in the specific field of study.

Elective learning offers learners additional, optional subjects to ensure that

- the purposes of the qualification are achieved,
- more specialisation is provided,
- an understanding of other career opportunities is provided and
- any subject of interest can be studied.

One or two elective subjects may be included in the programme (RSA, 1997:60; Department of Education, 1998:38, 40; RSA, 1998a:10, 14; Spady and Schlebusch, 1999:85).

4.5.1.3 Unit standards

Unit standards are structured to serve as work documents for educators, learners, assessors and verifiers. They are the building blocks of the programmes for the subfields and fields.

A carefully selected collection of unit standards can contribute towards a qualification in a study field or a skills programme. Their key components are:

- identification and classification,
- admission requirements,
- objectives and goals (outcomes),
- assessment criteria,
- value of its contribution towards the qualification (credits) and
- delimitation (range, scope, context and level) (RSA, 1997:57; RSA, 1998a:7).

Summarising all the basic facets of education, from the outcomes to assessment, unit standards are developed around a number of related outcomes forming a unit or a task comprising four to six outcomes (SAQA, 2000:36). The outcomes are the norms for accomplishing the competence of the unit as defined by them and contribute towards the development of the person – adding life skills and improving his/her frame of reference (knowledge, skills and values). "Outcomes are what students actually can do with what they know and understand" (Spady, 1994:49).

The "flow" diagram of a unit standards-based curriculum can be outcomes → units → modules → divisions → curriculum. This structure is regarded as suitable for unsuccessful school leavers' education because it facilitates the assembly of a qualification in differentiated education. Units can be "banked" until the accumulated accomplishments meet the requirements of a qualification.

4.5.1.4 Qualifications

A qualification is defined by Butterfield et al (2003:1325) as "an ability, quality, or attribute, especially one that fits a person to perform a particular job or task." This explanation reiterates Killen's (2010:52) version of outcomes-based education accentuating the ability of learners at the end of a programme. Attainment of a qualification therefore entails proficiency in a field according to the curriculum completed.

In the SAQA Regulations the requirements of a qualification incorporate

- a planned combination of learning outcomes;
- added value to the learner;
- benefits to society and the economy;
- fulfilment of the objectives of the National Qualifications Framework (NQF);
- inclusion of specific as well as critical cross-field outcomes;

- assurance that the purpose of the qualification is accomplished;
- attainment of a qualification, partially or in full, through recognition of prior learning;
- international comparability (RSA, 1998a:6).

The value of each unit achieved is quantified in terms of credits, which, in turn, are time related. A credit "impersonates" the time it is envisaged it will take an average learner to accomplish certain outcomes expressed in terms of notional hours. Ten notional hours of learning is the hypothetical value of a credit (RSA, 1998a:3, 4).

Although this concise evaluation of credits simplifies the process of assessing the contribution of units towards a qualification, significant factors are ignored, which brings the equality of qualifications in question. Levels of difficulty, complexity and importance to the unit standard should be incorporated (Anne Oberholzer, 5 September 2000. Interview in Klinck, 2001:91).

A learning programme is a series and an assortment of learning opportunities aiming at achieving specific, learning area and critical outcomes, guided by the unit standards involved (RSA, 1997:57–62; RSA, 1998a:7–9). Educators are allowed a free hand to develop learning opportunities utilising strategies, material, media, methods and techniques (Van der Horst and McDonald, 1997:49; De Jager and Hüster, 2003:8).

Learning programmes must be developed by educators according to the unit standards selected for the curriculum, compiled to fulfil the requirements of the qualification involved (De Jager and Hüster, 2003:8). Unit standards are listed by SAQA and they are at the disposal of people who want to compile curricula (SAQA, 2011: *Unit Standards*). The unit standards-based OBE is currently utilised for learnerships. OBE is, however, only one of a number of competency-based education approaches/models. Further elaboration on educational approaches is necessary to provide perspective on the topic.

4.5.2 TRANSDISCIPLINARY APPROACH TO CURRICULUM INTEGRATION

"The transdisciplinary model for education and research transcends the artificial boundaries imposed by traditional academic structures and directly addresses the problems..." (Ertas, 2000:15). Focussing on the current task, project or problem utilising whatever information is required from whichever subject or field and negating subject and field boundaries, signify a transdisciplinary approach.

Integrated approaches to education are attempts to align the process with learning theories and reality to establish balance, relevance and significance (Nordahl and Kofoed, 2008:2 of 7). Several levels of integration beyond the traditional intradisciplinary approach were developed comprising correlation (fusion), integrated theory and practice, multidisciplinary, interdisciplinary and transdisciplinary curricula (Nordahl and Kofoed, 2008:3 of 7; Appendix E). In Nicolescu's (2005:2, 3 of 12) terms, the continuum comprises disciplinary, multidiscipline-ary, interdisciplinary and transdisciplinary.

Curriculum-integration approaches facilitate learner participation in educational activities, stimulate innovation and make learning a pleasant experience. Learning content becomes more relevant and significant to learners when they can experience interconnections between knowledge from different subjects and applications in various ways (Drake, 1998:2–10). Educational integration for this study is derived from two continua by Drake (1998:20) and Nordahl and Kofoed (2008:3 of 7) (Appendix E).

4.5.2.1 Curriculum integration

The conventional (traditional) lecture, with virtually no integration besides references and sporadic application, is at the lower end of the continuum. In technical education, such as in the NATED engineering programmes, not even trade theory and practical training are integrated (HSRC/NTB, 1985:14). Similar to ancient Egyptian apprenticeships (2000 BC), the trade theory precedes practical training (cf. 2.2.1.2). The academic component of apprenticeships, including trade theory, is done at FET colleges and practical training at the workshops of employers. Lack of synchronisation of academic syllabi and practical training renders the arrangement of theory, preceding training, inopportune.

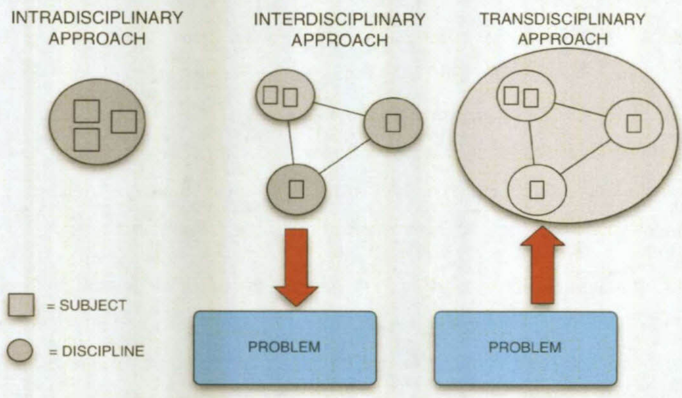
Subject integration or integration of theory and practical training, although still at the lower end of the continuum, at least signifies some form of integration. Two sub-disciplines are integrated into one subject, or trade theory and practical training are integrated into a knowledge package. Theory and practical training are still two components, but integrated into trade learning content, e.g. motor mechanics.

Multidisciplinary curriculum integration implies a curriculum with subjects taught separately, but connected through particular themes. Themes are covered in subject context by different subjects (Drake, 1998:43; Nordahl and Kofoed, 2008:2 of 7). From the perspective of different subjects, themes are studied to find application in specific curriculum objectives often allocated in a core subject. The contributions of different subjects culminate in accomplishment of a common (curriculum) aim.

Interdisciplinary curriculum integration concerns the transfer of knowledge and methods amongst a number of subjects across subject boundaries. Themes of a curriculum are covered by the subjects in the curriculum in the same timeframes. A problem can be cooperatively dealt with in the subjects of the curriculum without conceding their specific characteristics and focuses. Subject-educators collaborate and the work schemes are synchronised (Songca, 2006:223).

Transdisciplinary curriculum "integration" is assembling and incorporating knowledge from several subjects and fields into proficiency to accomplish the assignments and outcomes of the curriculum. It utilises a framework of strategies for compiling knowledge from several subjects and fields into problem solving or execution of assignments beyond integration of subjects (Drake, 1998:92; Ertas, 2000:15). The approach is not confined by subject or field boundaries as they only serve as sources of information. "Environmental problems and their solutions seldom respect faculty lines" (Carson, 2007:1 of 3). A graphic layout by Nordahl and Kofoed (2008:3 of 7) illustrates the concepts of intradisciplinary (no integration), interdisciplinary and transdisciplinary curricula and their problem-solving approaches.

Figure 4.3: Educational approaches to integration



(Nordahl and Kofoed, 2008:3 of 7).

In interdisciplinary approach knowledge from different subjects collaborate in solving a problem. Problems/projects are confined to subject boundaries. Transdisciplinary approach is initiated by a problem requiring information transcending subject boundaries. Competences required are incorporated in real world problems/projects negating subject boundaries. Transdisciplinary integration has features evoking further investigation.

4.5.2.2 Features of Transdisciplinary Curriculum Approach

Transdisciplinary approach to education is concerned with understanding the world through the unitary nature of knowledge. The environment is a dynamic complex unity of parts – entities and events continuously influencing and being influenced by one another. Studying the world or for that matter, reality, through separate subjects for the sake of subject knowledge is depriving learning of the richness offered by reality. It is breaking up the gestalt into isolated portions of information, which can at best only be unnaturally related to reality by some application or reference. Disciplinary (traditional) education tries (if at all) to integrate theory and practice or knowledge and skills with applications and cross-references. Transdisciplinary education is education beyond subject and discipline boundaries and relationships between and across subjects and disciplines (Nicolescu, 2005:2). Information and demands from reality is constructed into declarative and procedural knowledge, integrated and naturally.

Education, as an edifying part of reality, cannot operate in isolation or in isolated compartments comprising different fields of information and facets of human existence. A curriculum should provide for an interwoven, interrelated set of parts in right and healthy relationships, functioning as a unit within real life, contributing to the development of an "entity", a human being. Providing the evidence of relationships and links between apparently disparate materials will show how things fit into larger contexts (Drake, 1998:14). "Students are less likely to internalise single, stand-alone curriculum events into their repertory of useable knowledge and competence" (Spady, 1994:15).

Transdisciplinary integration features in the project method, story-model, problem-based learning, hands-on approach (project education) of the Olin College of Engineering in Manhattan, United States of America (2009), the medical school of McMasters University in Ontario, Canada (2009), and even in the in-service training of apprentices and artisans in South Africa. At the Olin College, agricultural engineering students, *inter alia*, are confronted with an agricultural problem and they have to design and build a machine or vehicle to solve the problem. At McMasters University, medical students are confronted with a complaint of a patient and they have to diagnose the illness, prescribe treatment and supporting medicine. The Olin example can be classified as problem-based or project-based depending on the focus, but the McMasters situation it is more problem-based. There is no clear distinction between problem-based learning and transdisciplinary education. Killen (2010:249) and Woolfolk (2010:318) give explanations of problem-based learning that is directly applicable to transdisciplinary education.

In transdisciplinary education, subjects are not offered separately. Learners are confronted with a task. Investigation and analysis enable the composition of a "knowledge package" required (examining the patient and making a diagnosis) (Woolfolk, 2010:318). Information from all relevant subjects and other sources is explored and utilised in the execution of a task. All the "units" are interrelated and linked, contributing to the enterprise. The desired objectives and outcomes are cautiously taken care of in the learning opportunities and exploration endeavours (Drake, 1998: 92–123).

Transdisciplinary education reveals the following features:

- Subjects are only sources of information.
- Information from different subjects is integrated through the assignments into the curriculum and not offered separately.
- The context of education is real world situations.
- Information is always relevant to the task.
- Learners are explorers and researchers.
- Learners make contributions and decisions.
- Standards can be added as deemed necessary.

This approach suits practicum-based education well. With projects/tasks as kick-off point, real world applications can be exploited in developing learning and discovery opportunities for comprehensive unsuccessful school leavers' education. Real life situations and problems are not as well constructed as simulated events in classroom conditions and therefore present greater challenges, but in unsuccessful school leavers' education more control is required considering the educational obstacles encountered and the educational level.

4.5.2.3 Transdisciplinary education concluded

The transdisciplinary education approach complements the fundamental theories of the study. Subject-focus is replaced by knowledge-focus, focusing on integrated acquisition of declarative and procedural knowledge from any field or subject that can provide the information required – learning being the essence of the exercise. The search for information and acquisition of knowledge must be allowed beyond the direct applicability to the task or project at hand. Information collection and knowledge construction, in increasing complexity and reduced relevance to the direct necessity and requirements of the practicum, should be endorsed. Relevance should not be a problem because the knowledge originates in the practicum, the problems experienced and curiosity evoked.

4.5.3 PROJECT-BASED EDUCATION

Project-based education is practical hands-on education focusing on integrated perceptual-motor and cognitive development – integrated declarative and procedural knowledge construction. It originated in the late sixteenth century in Italy in architectural schools and reappears from time to time in some form or other (Knoll, 1997:2). The opportunities it provides enhance balanced edification towards independence, responsibility, innovation and cooperation. Integrating theory and practice or knowledge and skills lay the foundation for holistic competency-oriented programmes. Individual and group projects are incorporated in educational programmes for accomplishment of the desired outcomes in cognitive, psychomotor and social skills (Fogarty, 2001:78).

Although the distinction between project-based education and project-based learning is only a matter of focus and dimension, clarification is regarded necessary. Project-based education is execution of an interdisciplinary (separate subjects) or transdisciplinary (no subject focus) project-based curriculum. Subject knowledge is acquired while working on interdisciplinary or transdisciplinary projects. Project-based learning, on the other hand, can be applied in a specific subject focusing on a specific division of that subject (Ravitz, Hixson, English and Mergendoller, 2011:2). Referring to the "central concepts and principles of a discipline" confines the strategy to the description given. Pucher, Mense, Wahl and Schmöllebeck (2003:1) call project-based learning "an instructional method that challenges students to develop the ability to think critically, analyse problems, find and use appropriate learning sources," thereby confirming the explanation above.

Projects comprise well-planned investigation, analysis, planning, design and calculated execution. In the process the planning, investigative, design, perceptual-motor and intellectual skills of the learners are developed. The role of the educator is that of facilitator of opportunities. Designing significant assignments, coaching the learners in knowledge and skills development, monitoring and assessing progress are educator contributions. Project-based education is task and content driven (David, 2008:80).

Educational projects can be structured or open-ended. Structured projects have specific boundaries, well-defined objectives and outcomes predetermined by the curriculum and the facilitator/educator (Fogarty, 2001:79). Open-ended projects do not have specific boundaries, are real world problems with indeterminate goals and offer more complex learning experiences (Hauer and Daniels, 2008). Open-ended projects are not considered for unsuccessful school leavers' education (Henry, 1994:15). Independent research, design and problem-solving skills are beyond the educational level of unsuccessful school leavers.

On the curriculum-integration continuum, project-based education is at least interdisciplinary, incorporating knowledge from different subjects to accomplish the objectives of the project. The description of project method in vocational education, given by Tippelt and Amorós (2003:8, 9), signifies the level of integration they advocate, which correlate with interdisciplinary education. The emphasis is on cognitive and perceptual-motor development of the learners. The project is merely a means to the ends: intellectual development and competence. Project-based education utilises real-world projects exposing learners to real life situations. Projects can be any real-world situation, making the possibilities virtually endless.

Projects provide dynamic learning opportunities taking learners through sequences and stages of development, all contributing to learner edification. Execution of projects goes through the phases of conception, configuration, contradiction, confusion, reconfiguration, culmination and celebration depending on circumstances (Fogarty, 2001:78). Projects do not necessarily go through all the phases mentioned. Besides declarative and procedural learning attributes to be mastered, each phase is accompanied by emotional consequences. Learners are holistically involved in the education: cognitive, affective, psychomotor and volitional (De Block, 1978 in Krüger and Müller, 1990:48).

Projects necessitate full participation of learners. Learners are obligated to focus their attention on the task and the calculated execution of every facet and stage of the process. They need to be aware of the knowledge requirements incorporated in projects. These requirements are included in the outcomes and assessment criteria for projects – determinants of success.

4.5.3.1 Key features of project-based education

The aim of project-based education is to capture learners' interest with thought-provoking real-world problems (David, 2008:82). In the process of involving the learners in real-world projects, learners acquire and apply new knowledge. Projects must be significant to the learners. Striking, stimulating, challenging, progressing and meaningful projects will be appealing to learners. The challenge to educators is to maintain motivation and focus and to keep stimulating the learners, which is possible with continuous "involvement" and interest in progress, solutions and procedures. Continuous assessment of procedure, progress and individual contributions necessitate incessant facilitator attention.

Project-based learning develops decision-making skills. Making decisions is permitted and mistakes tolerated to ensure that learners develop a sense for errors and consequences. Tasks and responsibilities must be clearly defined and communicated (Tippelt and Amorós, 2003:10). In group projects, responsibility is essential and each team member must be well informed about rules, duties and schedules. Communication and interaction provide opportunities for peer teaching, assessment and motivation.

Project-based education facilitates development of learning habits, attitudes, strategies and techniques. Learning how to obtain, display and manipulate information is part of the procedural knowledge incorporated. Participation and commitment of the learners is crucial to the success of the endeavour.

Learning new concepts from projects is meaningful, because relevance and significance are incorporated in the experience exemplifying natural human learning. Contributing further to the establishment and retention of knowledge is the application of the concepts in tasks constituting projects. Learners do not only take responsibility for the execution of the task, but also take ownership of the knowledge and skills acquired. Learning is independent and personal. This affords opportunities for promoting learners' thinking skills (Pucher, Mense, Wahl and Schmöllebeck, 2003:6).

Project outcomes specify cognitive and perceptual-motor development expected. Careful stipulation of learning content (information) across subject boundaries ensures that the outcomes are covered. The learning content incorporates concepts, theories, methods, techniques, procedures, materials, measurements and basics of task execution. Projects have parameters to provide some form of criteria to guide learners and educators. Enthusiastic innovative learners may go overboard while others may fall short if they do not have sound guidelines to go by.

Monitoring and continuous assessment of learning is essential. Execution of a task should result in the desired learning throughout the stages. Continuous assessment of what has been done, how it was done, how learning occurred and timely, comprehensive feedback are integrated elements of project-based education. Timely intervention is essential if the criteria are not met.

Learning of declarative knowledge relies on project progress, information processing and sharing. Procedural knowledge is acquired by active participation in the psychomotor activities. Knowledge acquisition is assessed throughout the duration of the project while monitoring the procedure and progress. This is essential to the success of project-based education because schedules are tight and projects are time-consuming. Cognitive development is fundamental to the success of project-based education and an integral part of the assessment. All learning, i.e. acquisition of declarative and procedural knowledge, is cognition based although in different faculties of the brain (cf. 4.2.2.2.8.4; 4.2.2.2.8.5).

Project-based education progresses from basic orientation to more complex projects involving critical thinking and problem solving, challenging and developing the higher mental skills of the learners. Programme progress should cover Bloom's taxonomies of cognitive learning outcomes and psychomotor development. Developing listening, communication and collaborative skills, rational thinking, taking ownership of own learning and success constitute the basic objectives of project-based education.

4.5.3.2 Basic structure of projects as education mode

The **first stage** of a project is the information collection process, which involves reading, researching, interviewing and fact gathering – using references, finding resources and collecting data (Fogarty, 2001:81; Tippelt and Amorós, 2003:13). Collecting quality, relevant and substantial information is vital to the progress and development of the project and the learners. It requires commitment, integrity, careful consideration and sound judgement to accomplish the set standard.

Information processing is the **second stage** of the project comprising, according to Fogarty (2001:83), three "sub stages": analysis, categorisation, prioritisation and synthesis with categorisation and prioritisation combined as the second sub stage. The information is scrutinised for relevance and significance and sorted into meaningful chunks to make it manageable. Calculations are done, sketches made, specification recorded and material listed. Linking these chunks leads to the generation of ideas, manipulation and comprehension of the information and drafting of solutions in preparation of application.

Putting the plan into action is the **third stage** of the project comprising measures, procedures and techniques. Manufacturing, constructing and assembling are the psychomotor activities in a process of acquiring perceptual-motor and intellectual skills. Testing, evaluating, reconstructing and appreciating finalise the process (Fogarty, 2001:81–85).

With innovation and improvisation, key aspects of project-based education can be incorporated in virtually any classroom situation (David, 2008:80). According to David (2008:81), Boaler (2002) reported significant achievement of students who were on project-based learning programmes in Great Britain. They did better in mathematics, conceptual knowledge and applied skills than did their compatriots on traditional programmes. Similar results were reported at the Vanderbilt University (1992) (David, 2008:81). Less math anxiety and more positive attitudes toward mathematics have also been reported. A finding significant to the South African educational scenario is the reduced correlation between economic level and learning performance in project-based education. David (2008:81) reports that Boaler found, "The link between performance and student economic level disappeared in the project-based school and increased in the traditional school." The negative effect of low family income on education is reduced by project-based learning.

4.5.4 PROBLEM-BASED LEARNING

Problem-based learning, derived from the project method developed by William Heard Kilpatrick (1918), confronts learners with real life problems that they have to solve. According to Drake (1998:93) great success was achieved by the medical school at McMaster University in Ontario, USA. With the problem (patient illness, for example) as motivation for acquisition of knowledge, students plan, research, study and work towards a solution to the problem. Further developments of this approach in education improve the features of schooling and look promising, but the concern in this study is on a lower level – get unsuccessful school leavers involved and learning.

The distinction between problem-based and project-based education can be found in the definitions of project and problem. The explanation Hattingh and Killen (2003:40) give for problem-based learning clearly identify the "difficulty" students experience in integrating "knowledge from a fragmented curriculum", which is an indication that they refer to education. They further mention the attributes of problem-based curricula in organising content around "authentic problems", signifying the concept. Problem-based education focuses distinctly on the development of critical thinking and problem-solving skills. "This approach to teaching retains the emphasis on learning about the subject through solving problems, rather than simply learning how to solve problems by applying algorithms" (Hattingh and Killen, 2003:41).

The indiscriminate use of the concepts problem-based learning and problem-based education can cause confusion because problem-based learning can be confined to a specific subject. Various authors also use these terms and problem-based and project-based randomly.

Since there is no clear distinction, project-based education can be regarded as the approach where learners/students handle hardware projects with the focus on the project, which can be described as a practical assignment or task. Problem-based education focuses on the problem that can be any kind of problem students are confronted with. Problem-based and project-based education reveals characteristics resembling transdisciplinary education.

In unsuccessful school leavers' education the focus should be on "projects" rather than "problems" considering their educational level, foundation and shortcomings of the learners. The emphasis should be on the practicum (procedures, how to ...) in an effort to accomplish cognitive and perceptual-motor development.

The focus in this study is on approaches to education that can overcome the learning barriers of unsuccessful school leavers and be appealing and encouraging to them to continue with their educational careers. The similarities between problem-based and project-based education renders further discussion superfluous.

4.6 CONCLUSION

Learning styles, discussed in section 4.3.2, are preferred ways of observation/learning. This "preferred way of going about learning" and "preferences for particular learning environments" distinguish learning preferences/styles from psychological learning theories. Learning styles do not provide substantial answers to the question of how learners learn. The identified styles are superficial and lack fundamental substance. They offer nothing that can enhance understanding of learning or contribute to the practicability thereof.

Besides the validity and credibility issue, learning styles do not have any proven record of improving education. It is an established fact that learning preferences are not decisive in education. Learners, quite frankly, participate with success in presentations differing from their preferences. The contribution of learning styles to education is doubtful and their insignificance for unsuccessful school leavers' education is apparent. It would be a waste of time and resources to incorporate any of their "attributes" in the envisaged curriculum.

In the absence of psychometric tests to determine the scale of "multiple intelligences" or evaluate learners' abilities and predict performance in educational situations, the theory of "multiple intelligences" cannot make any contribution to unsuccessful school leavers' education in this regard. None of the features of "multiple intelligences" seems to have significant value for learning opportunities. Educational strategies derived from fundamental learning theories, e.g. constructivist learning, are more appropriate to enhance learning and involve learners in the educational activities.

Constructivist education is learner-centred education with facilitating scaffolding educators, based on collaboration and interaction (Carl, 2010:141). Learners construct their own knowledge from incoming stimuli on a foundation of existing mental representations (Killen, 2010:8). These are the fundamentals for the envisaged curriculum and concomitant education. How learners learn and how learning can be facilitated are essential premises for learning opportunity planning. Learner differences should be taken into account when preparing learning opportunities. These should include aptitude, level of development, background knowledge and interests (Reiner and Willingham, 2010:34).

Chapter 5 is an account of the research aimed at consolidating the perception of the educational situation of unsuccessful school leavers and the processes of the curriculum design. Captured in the empirical research, the perceptions of senior personnel and learners in engineering studies at FET colleges are regarded important information complementing the requirements of the design of the envisaged curriculum. Providing perspective on the educational situation and educational needs of unsuccessful school leavers, the information matches the theoretical foundation of the study and the process of converting the theories into applicable practicable format. The practicable format of the research results is accomplishment if the aim of the study: a transdisciplinary practicum-based curriculum designed to accommodate the educational needs of the unsuccessful school leavers, is reached. Alleviating the unenviable educational situation of a group of unsuccessful school leavers will be vision realised and mission accomplished.

It can be concluded that the research endeavours to determine the perspectives of senior personnel at FET colleges of the attributes of the unsuccessful school leavers in engineering studies and the perspectives of the learners on their educational situation. Integrating this information in the process of curriculum design, should culminate a transdisciplinary practicum-based curriculum appropriate to facilitate education for these learners.

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CHAPTER 5

EMPIRICAL RESEARCH ON THE DESIGN OF A TRANSDISCIPLINARY VOCATIONAL CURRICULUM FOR UNSUCCESSFUL SCHOOL LEAVERS

5.1 INTRODUCTION

Proposing provision of "second chance" education to unsuccessful school leavers signifies a curriculum design based on a curriculum theory incorporating a design theory, fundamental learning theory, accommodation of learner differences, an appropriate educational approach and data derived from an empirical research. A curriculum theory was established in Chapter 3, complemented by a fundamental learning theory and an apposite educational approach in Chapter 4.

The empirical research is designed to determine the perspectives of stakeholders (senior personnel and learners) in engineering studies at FET colleges, on the attributes of unsuccessful school-leavers and their educational situation. These perspectives are the primary empirical contributions towards the design of a curriculum for unsuccessful school leavers according to applicable curriculum development principles, learning theories and literature information. The collection of the required information and acquisition of the procedural knowledge to accomplish the task is termed "capacity building" (Holland and Campbell, 2005:1-9; Phillips and Pugh, 2008:52, 54). The process of curriculum design is guided by the design theory complemented by empirical data, continuous developmental and external benchmarking.

5.2 RESEARCH DESIGN AND METHODOLOGY IN VOCATIONAL EDUCATION

Endeavouring to attend to an educational situation categorises the study as applied research (Lategan, Vermeulen and Truscott, 2003:1−3; Myers, 2007; Phillips and Pugh, 2008:51). Within the basic type of applied research it further differentiates into a subcategory, problem solving. According to a notion of Phillips and Pugh (2008:52), this study can be typified as problem-solving research because the aim is to propose a specific curriculum as an attempt to alleviate the unfavourable educational situation of unsuccessful school leavers. They mention that this type of research often crosses discipline boundaries because real-world problems are normally complex and not easily confined to single academic disciplines. It is applied, problem-solving, mixed-methods research, comprising a literature study crossing boundary lines of educational psychology, historical pedagogy and curriculum studies to name but the major disciplines. The study includes statistical evidence and reports, curriculum evaluation and empirical research aimed at collecting quantitative and qualitative data to establish knowledge and perspective on the educational situation of unsuccessful school leavers.

Quantitative and qualitative research data are required to ascertain the unsuccessful school leavers' situation and elucidate information from reports and official statistics. Complementing each other, these two types of research impart a richer, deeper meaning to the investigation, combining quantitative evidence and qualitative interpretation to enhance understanding and establish context, thus providing a holistic picture (Neuman, 2000:122; Holland and Campbell, 2005:3–5; Maree, 2010:258, 259).

Social sciences research affords the apparatus, methods and techniques for the establishment of the knowledge base, data and statistics required for the objectives and aim of the study. Selection of the approach, apparatus, methods and techniques are stipulated by the nature of the problem and the information required. Confirming the situation requires official statistical evidence from educational sources, reports on education and empirical data. The educational situation of unsuccessful school leavers, appropriately established, supposes acquisition of information in various aspects of education: background, context, fundamental theory, approach, strategies and methods signifying literature study supported by practicalities derived from empirical data.

5.2.1 LITERATURE STUDY

Education for the envisaged mechanical skills curriculum for unsuccessful school leavers is structured on a literature study framework comprising a background (historical context, Chapter 2), context (Chapter 2), curriculum design theory (Chapter 3), fundamental learning theory and accommodation of learner difference (Chapter 4), educational approach and educational strategies (Chapter 4). Each of these aspects, covered by the literature study, needs to be linked with the educational situation of unsuccessful school leavers in South Africa (cf. 1.5.1). Links can be established by means of the data obtained from an investigation into the educational situation of unsuccessful school leavers. A situation analysis of their educational situation can be accomplished with empirical research complemented by the mentioned literature study. The empirical research provides the means, mode and manner of collecting the required information, processing it and allowing for inferences.

Each of these aspects of the curriculation framework contributes to the construction of the curriculum and consequently, to the education constituted by the curriculum. The detail of each aspect of the literature study is discussed in the relevant chapters. Only the basics are therefore elaborated upon in this discussion of the facets of the research.

5.2.2 EMPIRICAL RESEARCH

The empirical research is a more detailed facet of the investigation into the unsuccessful school leavers' educational situation than the official statistics, reports and literature because the former reflect only end-results (cf. 1.5.3). Focusing more on the experiences, opinions, perspectives, beliefs of and evidence given by the participants in the investigation provide an opportunity to construct a "picture" of the educational situation of the learners involved. Confirmed by the official statistics and reports, the educational situation of unsuccessful school leavers' needs to be investigated from the perspectives of the people involved.

Learners, programmes and facilities are the "objects" studied with the senior personnel instrumental in the process to acquire a better understanding of the educational situation of unsuccessful school leavers outlined by the official statistics and reports. Inputs of the learners are included in the data collection for improved perspective. Understanding the situation requires information for substantial elaboration and consideration of appropriate actions in the quest to address the educational needs of unsuccessful school leavers. Information acquired from the empirical research, integrated into the literature study information, will constitute the guidelines for the curriculum development and subsequent education model.

The required information must provide answers or contribute to answering the research and associated subsidiary questions (cf. 1.3). These answers must include quantified data that can reveal significance of occurrences, features and tendencies. In order to improve conceptualisation and interpretation of the educational situation – a human phenomenon which is difficult to quantify – another facet must be added for perspective (Creswell, 2008:552). According to Holland and Cambell (2005:127) "a fuller understanding of a multidimensional subject" can be attained with "various perspectives", which is considered essential for a comprehensive study constituting designing a curriculum. It was therefore imperative that mixed-method empirical research be considered the viable option.

5.2.2.1 Research approach

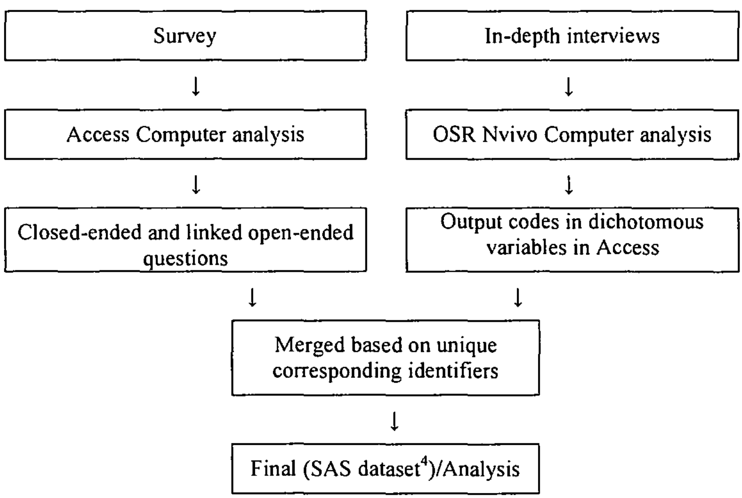
Quantitative and qualitative research methods are regarded as complementary in a mixed-method research approach (Creswell and Garret, 2008:326-328). Combining different approaches in research appears obvious considering their individual strengths and weaknesses. Adding their intrinsic characteristics to the argument, it is evident that by exploring their properties and complementary features a richer, deeper understanding of the area of investigation can be attained (Casebeer and Verhoef, 1997:5). Considering the complexity of the educational situation of unsuccessful school leavers and diversity of the information required, justifies the choice of a mixed-method research approach. Features of quantitative and qualitative research methods are discussed for clarity and orientation.

5.2.2.1.1 Consequential mixed method explanatory design research for the study

Following up a quantitative survey (questionnaires) with a qualitative investigation (interviews) categorises the study as an "explanatory design" (Creswell, 2008:560). Maree (2010:266) asserts that exploratory mixed-method qualitative findings are used to elucidate quantitative data. "Quantitative results provide a general picture of the research problem while the qualitative results refine, explain or extend the picture." A quantitative survey is followed by a qualitative exploration of experiences, perceptions, perspectives and beliefs.

The consequential mixed-method approach is illustrated by Driscoll, Appiah-Yeboah, Salib, and Rupert (2007:21) in the Diagram 5.1:

Diagram 5.1: Consequential mixed-method research



Driscoll, Appiah-Yeboah, Salib, and Rupert (2007:21)

It is, however, not a situation of just "explaining", but a great deal of exploring. Magnitude, frequencies, opinions, possibilities and prospects are characteristic features of the information required, reiterating the necessity for a mixed-method approach. The prime concern is justification for the conclusions made and development of a curriculum that can provide education for a specific group of unsuccessful school leavers and serve as a guide to offer the kind of education suggested by the research question.

[4] Computer programme

Classification of research paradigms or categories is an arrangement with vague borders without a definite crossing-over into another domain. "It may be unwise to draw a hard-and-fast distinction between qualitative and quantitative studies. The difference is not absolute; it is one of emphasis" (Best and Kahn, 2003:280). Examples are the structured questions of interviews and the open-ended questions of questionnaires. A relentless focus on the differences deprives research of the richness mixed-methods offer (Johnson and Onwuegbuzie, 2004:14).

Nevertheless, two methods are of concern in this mixed-method research: quantitative and qualitative research. Quantitative research provides the quantitative measures of the research: numerical values, magnitude and frequencies. Davies (2007:120) regards "frequency distributions the bedrock" of a study, providing the "basic facts" ("descriptive statistics"), which are ***essential for confirming the situation and establishing a foundation for further investigation***. Qualitative research provides the beliefs, opinions, expectations, perceptions, experiences and interpretations (Best and Kahn, 2003:260). Inductive reasoning is the inference mode of qualitative research.

According to Thomas (2003:31) a literature study can be complemented by a mixed-method empirical research comprising quantitative and qualitative investigations, supported by official statistical evidence and reports. The additional information needed in this study is obtained from personnel involved in the education unsuccessful school leavers are attempting as a last resort. When learners are in a situation resembling that of unsuccessful school leavers, precautionary educational measures to prevent dropout from schools, are immaterial. These are therefore excluded. The focus will be on the current educational situation of unsuccessful school leavers being the consequence of school dropout, which, according to UNESCO statistics (cf. 1.1; Hoffman, 2008), will not change other than scale. It is, however, essential to establish credibility of the research.

5.2.2.1.2 Quantitative survey approach

Quantitative research is often regarded as "real scientific" research because it studies measurable, quantifiable matter according to predetermined structures with standardised instruments and it excludes human subjectivity to some extent. A repeatable course with a prearranged sequence is followed in quantitative research. Data associated with formulated variables (or hypotheses) are collected according to the programme designed during the preparation stage (Neuman, 2000:122). The quantitative research method considered, is a questionnaire survey for the collection of data regarding the educational situation of unsuccessful school leavers in engineering studies at FET colleges.

The intention with the quantitative inquiry is to establish an information base on the educational situation of unsuccessful school leavers, their current options in education and possible alternatives to address their educational needs. This information base provides the guidelines for a qualitative investigation and triangulation of the research. Creswell (2008:62) posits, "... problems best suited for quantitative research are those in which trends or explanations need to be made". Determining what is going on facilitates explanation of a situation and provides a "launch pad" for further exploration. Elaboration on the features of the method provides justification for its incorporation in the mixed-method research approach of the study.

Open-ended questions and rating scales that must be interpreted, give the questionnaire a qualitative feature and greater depth in the responses (Best and Kahn, 2003:302). Structured questions restrict the possibility of discoveries, but the addition of open-ended questions and carefully constructed rating scales can contribute to a more balanced instrument. Even the other results of questionnaires may involve some degree of interpretation and conceptualisation. With dual-purpose questionnaires the combination of qualitative and quantitative research becomes evident and accentuates the faint margin between them (Patton, 2002:5; Best and Kahn, 2003:279, 280).

Questionnaires have inherent weaknesses, which must be borne in mind and counter-measures taken to limit the negative effects on the research. Questionnaires want answers just by asking questions which are predetermined. The only choice is between two or more answers for the same question in homogeneous questionnaires. There may be doubts as to whether the responses reflect the true beliefs, thoughts or feelings of the respondents, but interviews, telephone interviews and sensitivity for inconsistency can counter many of the negative effects. The questions asked result in the predetermined answers given except for open-ended questions (Gillham, 2004:4). Although the honesty of the respondents may be in question some counter-measures can be applied to minimise the problem. These measures, confidentiality, personal interest, relevance and motivation, are discussed under the heading, Questionnaire development.

People do not always take questionnaires seriously (Best and Kahn, 2003:301). Cox and Cox, (2008:43) posit that "the world's best questionnaire" is no "guarantee" for adequate responses. Low response rate is a major concern with questionnaires (Neuman, 2000:266). It is therefore imperative to employ measures in an attempt to maximise responses. The exercise is too important to be jeopardised by insufficient returns. Explaining the purpose of the questionnaire and the implementation of the results is important in an attempt to establish a positive attitude of respondents. Ensuring that the topic is of interest to the respondents may not guarantee earnestness, but it could be of assistance in getting questionnaires completed. Relevance to aspects of their everyday life may cause people to give it a second thought and this may arouse a little more interest. The key aspect is the motivation in the explanation and guidelines of the questionnaire. Response rate is further discussed under Questionnaire development.

A sequence of predetermined steps is followed to obtain "physical" data – values for the variables – from which the conclusions are drawn. General validity can be secured by replication of procedure and comparison of resultant data. Deductive in nature, a general conclusion may be devised from a set of premises derived from replicated data. Quantitative research relies on objective technology, measures, implements and mechanical techniques, which can only produce hard physical evidence, diminishing human interpretation. The whole process is carried out according to a predetermined structure and instruments or tests (Jennings in Holland and Campbell, 2005:28, 29).

Cox and Cox (2008:3) posit, "The success of the entire inquiry rests on the clarity and relevance of the questions." The questions should not mean different things to different people. Questions should be specific and to the point. The responses must tell you what you want to learn. This can be achieved by focusing the questions on the specific desired information, opinion, belief or evidence for judgement. Great care must be taken to avoid leading key statements and questions because this may jeopardise the credibility of the research. Davies (2007:72) warned against leading questions, regarding it to be "one of the hardest areas of all to get right." Avoiding hypothetical questions and loaded phrases will favour the exercise because leading or misleading the respondents may place reliability at risk. Denotation sensitivity in drafting questions can avoid ambiguousness and also enhance clarity.

Clear, concise and easy instructions and key statements play a pivotal role in the success of a questionnaire. Different interpretations will lead to dissimilar perceptions and misleading responses. Gillham, (2004:28) posits "...the overriding rule is that it should be immediately clear what the respondent has to do". Careful explanation of the purpose and implementation of the results can contribute towards clarity and motivation, and explaining the scales and ratings is essential in securing accurate and honest responses. "If respondents are clear about what you are trying to find out and why, they are much more likely to respond appropriately and helpfully" (Gillham, 2004:38). The implementation of these guidelines can be judged by the responses obtained with the questionnaires.

Superlative phrasing may look impressive, but can complicate the questionnaire. Short questions with simple construction of sentences and cautiously selected wording do have a better chance of acquiring the desired results (Brenner, Brown and Canter, 1987:66). Burgess, (2001:11) agrees that questions should be "brief and clear" and ambiguity avoided. There is a better chance of avoiding ambiguity and enhancing clarity when simplicity is applied.

Responses that deviate from the actual situations denote bias and impair the validity and reliability of the research (Tustin, Ligthelm, Martins and Van Wyk, 2005:387). Compiling questions and answers simultaneously and careful consideration of the sequence and wording of questions may contribute towards limiting the occurrence of bias. Prejudice and preferences may still influence the responses, but crosschecking – different types of questions on the same items – can counter deceptive responses. Triangulation, as far as it is possible with questionnaires, interviews and relevant documentation, can further contribute towards unravelling the feedback.

Further valuable suggestions in drafting a functional questionnaire which produces the desired results are the following:

- Respondents can be encouraged to complete the questionnaire by starting with questions addressing the concern of lecturers in engineering at FET colleges. The poor results of unsuccessful school leavers suggest learner educational performance as a prime concern.
- Logical and natural order can ensure sequential answering of the questionnaire (Creative Research Systems, 2006).
- Encourage answering in a specific sequence and capture the respondents' attention with questions within the subdivisions that lead into each other – each question should be a follow-up of the previous one (Gillham, 2004:27).
- Maintaining the interest of the respondents will improve the quality of responses and thereby the value of the research. Relevance and significance, although difficult to establish, can evoke interest in specific constructs.

Grouping the questions according to theme provides structure and logic to the questionnaires. Respondents may answer questions randomly, but carefully considered grouping according to relevance and logical sequence can inspire them to follow the desired sequence. The real problem with this aspect is questions that are left unanswered leaving gaps in the data contexts.

Questionnaire development can be done according to a guide substantiating the format:

- Write a descriptive title.
- Write an introduction.
- Group the items by content.
- Write a subtitle for each group.

- Also group the questions in factual, opinion and behavioural categories.
- Sort the items by format.
- Give concise and clear instructions of the procedure to follow (Arsham, 2011:4 of 23)

This guideline can serve as benchmarking criteria for questionnaire development and writing.

Carefully compiled questionnaires are valuable instruments in the initial data-collecting facet of a sequential mixed-method empirical research. It is, therefore, important to pre-test the instruments to reduce setbacks as far as possible. Piloting of the questionnaire(s) and thorough evaluation are essential facets in the development because misinterpretation, leading to fake data and unreliable results, cannot be corrected afterwards (Burgess, 2001:15). Phillips and Pugh (2008:84) suggest that a pilot study can determine whether an investigation can work or not. Du Plooy (2005:93) mentions the necessity of piloting to determine relevance and effectiveness. Some of the questions may unintentionally cause confusion. Testing of the questions for changing responses when the phrasing is changed is necessary (Robson, 1993:249). Ambiguity, bias and misinterpretation can be identified and eliminated before the questionnaire is finalised and administered. At the same time, it can be assured that the essential elements in the research are covered.

Discovery of missing data at a later stage can cause havoc and it will be difficult to convince respondents to do an extra questionnaire covering the missing information. Redundant questions, not really contributing to a better understanding of the study and questions, possibly unacceptable to respondents, can also be eliminated making the questionnaire more appropriate and tolerable (Creswell, 2008:402). The responses must serve the purpose of the research providing the "material" to be "digested". Careful consideration and evaluation can limit the pre-piloting errors, making the finalisation easier and reducing the risk of inadequate or unreliable answers in the responses.

A more relaxed atmosphere can be created for the respondent if confidentiality is guaranteed. This will free respondents from the concern of perceptions that may reflect negatively on them. Questions can be answered honestly, knowing that there will be no reflection on a person (Cox and Cox, 2008:45).

Well-designed and drafted questionnaires should not be compromised by a poor introductory letter accompanying them. The letter should arouse interest in the research and encourage participation. Reading the letter is the crucial moment in the decision of participation or rejection. Time spent in drafting the letter is time worth spending in this critical stage of the whole endeavour.

5.2.2.1.3 Qualitative inquiry

It is difficult to quantify opinions, beliefs, perceptions, experiences, interpretations, perspectives and attitude because they are aspects of the human psyche. Conceptualisation is based on interpretation of these aspects of peoples' psyche from the perspectives of the qualitative approach (Davies, 2007:152). Studying phenomena which can hardly be expressed in numeric value, be quantified or formulated in definite variables and hypotheses, justifies an approach emphasising interpretation, confirmation of evidence, consistency and authenticity as norms utilising inductive reasoning. These basic norms, together with coherent reporting, are fundamental to qualitative research (Thomas, 2003:1). Qualitative research is also referred to as "participatory research", involving other people besides the researcher (Holland and Campbell, 2005:3). Objectivity and integrity of the researcher are vital to the validity, reliability and credibility of the study.

By nature, qualitative research is an inquisitive approach, studying social phenomena guided by curiosity and unfolding occurrences throughout the exercise. It can be described as cyclical, spiral, oriented toward constructing meaning, reflecting on the whole research and particular steps in light of other steps. Every cycle contributes to developing insight and holistic perspective based on phenomena previously experienced in the study, signifying a constructivist feature. New perspectives are constructed on previous relevant experiences denoting the involvement of the researcher in the process (Johnson and Onwuegbuzie, 2004:16). Although it is guided by the of the aim of a study and preceding quantitative data in mixed-method applied research, open-ended interviews cannot be restricted by the confines of a clear-cut programme and premises (Neuman, 2000:123, 124).

Structured interviews are similar to questionnaires and can in a sense be regarded as "oral questionnaires". Instead of written questions and statements, these are conveyed orally and the responses given orally. Depending upon the type of information needed, different types of interview can be explored. A predetermined schedule, checklist and questions will ensure better results although not success in data collection (Best and Kahn, 2003:323). Constructed interviews, equivalent to questionnaires (oral questionnaires), have limited ability to reveal new discoveries. Open-ended interviews were therefore preferred for this study.

Open-ended interviews have attributes allowing real respondent versions of the situation for better understanding the educational situation of unsuccessful school leavers. Depth, detail, interpretation and perspective can be improved with freely expressed opinions, feelings, beliefs and perceptions of the situation of unsuccessful school leavers (Best and Kahn, 2003:256). Interviews can disclose much information about the issue at hand, but they also have limitations.

All that the interviewees will reveal is their interpretations at that point in time. It is not possible to know what is withheld (Altrichter, Feldman, Bosch and Somekh, 2008:125). Allowing the interviewee to "bring the interviewer into his or her world" will open up knowledge and experience for exploration with carefully selected probing questions and statements (Patton, 1990:279). Statements and questions for interviews should be carefully planned, especially the probing questions in open-ended interviews, to fully explore the sources (Neuman, 2000:371). A genuine attempt to accomplish that may lead to disclosure of information beyond the initial anticipation.

Interviewers should not influence the responses by revealing their own opinions or being judgemental. They should be impartial, unbiased conveyers of the themes and questions, just observing and recording data. Questions asked by the interviewees should be carefully considered and an answer avoided or the question redirected (Neuman, 2000:276). An interviewer should be calm, neutral and objective, refraining from emotional reactions, even in terms of facial expressions and body language, except when nonverbal probing is necessary. Social etiquette and scientific ethics should be norms throughout the interview. Establishing a friendly, composed relationship with the respondent is of prime concern. Pursuing this aim, interviewers have a better chance of success in a friendly, co-operative atmosphere. Success achieved in this aim is revealed by the duration of the interviews and the data collected.

An interview goes through three stages: the introduction, after the interviewer has been introduced appropriately, starts with the explanation of the objectives and aim of the exercise. During this phase, rapport can be established between the interviewer and the interviewee (Neuman, 2000:276). The interviewee must be convinced that he/she will remain anonymous and no confidentiality breach will occur. Interviewees responded spontaneously, provide more information than required and elucidated the educational situation of unsuccessful school leavers, contributing to a better understanding.

During the second stage, the opening statements (stating the theme) are made or questions asked and the responses recorded. Elaboration on responses can remove uncertainties, thereby ensuring relevancy. Insufficient responses can be enhanced with suitable probing questions stimulating provision of additional information on the initial response. Interviewers must refrain from using leading, directive or suggestive probing questions. Careful selection and timing is crucial. The quest is for adequate, correct information to achieve the objectives and purpose of the exercise (Brenner in Brenner et al, 1987:24). The information provided by the interviewees is a valuable addition to the study, clarifying and enhancing the perception of the educational situation of unsuccessful school leavers in engineering studies.

The interview ends in the same friendly manner to avoid compromising the established relationship (Neuman, 2000:277, 278). No real conclusion, which may just reveal personal opinion and standpoint, can be given. Anonymity and confidentiality can be reaffirmed.

Tape-recording of interviews saves time and avoids unnecessary elaboration on responses for clarity. A further advantage of tape-recorded responses is that they can be replayed to enhance understanding.

Intentional, subtle observation during interviews can complement the enquiry (Robson, 1993:192). Facial expressions and other body language contribute to the interpretation and evaluation of responses. The delicateness of such observations and the fragility of their interpretations are fully appreciated. Telephone interviews rely on tone of voice, hesitations and fluency portraying levels of confidence, rather than facial expressions. Although not as expressive, telephone interviews can reveal some nonverbal connotations in a conversation.

This naturalistic character of qualitative research implies the absence of manipulation, control and predetermination of the outcomes (Patton, 1990:40–41). Compiling the script starts from the onset in qualitative research, because writing stimulates thought and enhances perspective (Myers, 2007). Throughout the enterprise, the information collected is interpreted and conceptualised. These concepts result in formulation of the report in a continuous process, thus influencing the development of the research and giving the study a recurring trend (Mouton, 2001:xiii).

During research, data, events, impressions, concepts and arguments are interpreted and the findings critically formulated in a coherent way. Understanding every aspect is crucial because the data must be translated, confirmed and reported objectively. Eventually it should contribute towards the formulation of concepts and the development of new perspectives essential for the resolution (Neuman, 2000:121–128).

Qualitative research is inductive in nature, meaning that several social realities are studied to draw a general conclusion from the collected data and interpretations thereof. "Induction is a process by which a general conclusion is drawn from a set of premises, based mainly on experience. The conclusion goes beyond the information contained in the premises and does not necessarily follow from them" (Butterfield et al, 2003:830). Evidence is collected to satisfy a curiosity, normally identified by a research question or set of questions. Interpretation of the data collected facilitates the formulation of a conclusion. Additional information reinforces the conclusion by contributing to it. In qualitative research terms, it confirms that data relevant to the research question are collected, processed, assimilated and a conclusion derived. It also applies to different facets and concepts of a research (Neuman, 2000:121–128).

The transcendent perspective of qualitative research exceeds the confines of structure, design and premise. It is often engaged in social change, encouraging people to go beyond current social conditions and thereby correlating with the goal and aim of this study – improving people's living conditions through education (Maree, 2010:259).

Observations, open-ended questionnaires, opinionnaires and interviews are data-collecting methods for qualitative research (Best and Kahn, 2003:280). Open-ended interviews were selected as feasible method to get a more comprehensive picture of the educational situation of unsuccessful school leavers by adding significance and clarity to the quantitative data.

5.2.2.1.4 Credibility

Research results must have value in order for the research project to have credibility and functionality. Credibility is established through validity and reliability. Validity is a feature demonstrated through relevance of the measurements with the matter to be judged or evaluated. Reliable means that the research must produce the same results repeatedly. Being reliable is a quality that ensures that results are accurate and consistent with the measurement taken.

Reliability and validity are features characterising an adequate questionnaire. Consistency in the responses is a feature a good instrument demonstrates, revealing reliability. The use of questionnaires already imparts an element of consistency, but well designed and formulated questions are still needed in order to harvest reliable results (Tustin et al, 2005:384). Measuring what it is supposed to measure qualifies the validity of the instrument.

Demonstration of consistency is necessary to achieve validity, but validity requires further qualification through measuring what is supposed to be measured. This crucial aspect adds value to research results making them usable for the purpose of the endeavour (Best and Kahn, 2003:277). Reliability and validity render research results credible and functional for whatever purpose they were intended.

A variety of statistical processes can be used to quantify reliability and validity of research instruments, e.g. by means of computer programmes determining various qualities, but a qualitative component in mixed-methods research adds difficulty to quantify attributes to the project (Best and Kahn, 2003:277). There are, though, other methods like triangulation to determine reliability and validity.

5.2.2.1.5 Triangulation

Looking at a phenomenon from different angles can verify the reliability and validity of the instruments used and the results obtained. This process is referred to as triangulation. Making use of different methods (mixed-method research) affords the opportunity of triangulation of method. Official statistics and reports provide another angle for verification and in some cases authentication. A variation on triangulation of observers can be obtained from different perspectives of different groups of respondents on specific occurrences or topics (Neuman, 2000:124, 125).

Triangulation is described by Davies (2007:34) as "... based on the idea of using two or three different methods to explore the same subject". Du Plooy (2005:39) confirms the concept by stating that utilising "two or more data-collecting methods and reference to multiple sources of data, are referred to as triangulation". In this study triangulation is based primarily on triangulation of method – correlating and comparing data obtained by different methods of investigation: quantitative investigation, qualitative inquiry, official statistics and relevant literature.

Maree (2010:39) considers triangulation "critical in facilitating interpretive validity and establishing trustworthiness". Positive correlation of data from different methods should correlate positively to meet the criteria of validity and trustworthiness – and for that matter reliability of quantitative data in terms of measuring repeatedly what it's supposed to measure. In this study correlation is taken further to include official statistics and literature information.

5.2.2.2 Target population

A target population is a group of people with commonalities/characteristics of interest to a researcher – a specific stratum in a population based on specific characteristics. Occupations, qualifications, learners in a specific educational programme or educational situation are examples of commonalities grouping people together. When it is impractical to involve the whole group, researchers adjust the survey to sampling (Best and Kahn, 2003:12).

Sampling is a method of selecting a representative portion of the target population. The sample should yield a reliable result closely resembling the anticipated outcome of a population survey. Selection of participants in this research was predetermined by the aim. The process, however, resembles features of stratification and convenience sampling (Best and Kahn, 2003:16, 17; Maree, 2010:175, 177). Confining the research to manageable size, similar definable characteristics, acknowledged experience and perspective on the situation of the learners and representativeness of the objects as well as the participants in the study led to selection of engineering studies at FET colleges.

5.2.3 EMPIRICAL RESEARCH PROCEDURE

Assessment of the educational situation of unsuccessful school leavers requires factual evidence and experiences of the people involved – their opinions, beliefs and perspectives of the reality they experience. These two types of information denote reconstructed logic and logic in practice (Neuman, 2000:122). Holland and Campbell (2005:142) posit that quantitative data allow general statements while qualitative data affords understanding of "informants and their complex social situation." Reconstructing what people know about a situation and constructing a holistic interpretation of their experiences, feelings and reflections, constitute their account of the situation.

5.2.3.1 Information required

A diverse collection of data, ranging from fact to judgements and opinions are required in the exercise to compile a presentation of the educational situation of unsuccessful school leavers as close as possible to reality. All these aspects ought to be covered by the questions and probing contained in the questionnaires, interviews, telephone and "Skype" interviews (Best and Kahn, 2003:301). The empirical research should substantiate the educational situation of unsuccessful school leavers in engineering studies at FET colleges engendered by their preceding education, current programmes and learner attributes supported by participant perspective. Supplementing and concluding this facet of the empirical research are aspects of addressing the situation, e.g. participant perspectives.

Questionnaires and interviews are selected to collect the information to substantiate these aspects. Exploring unsuccessful school leavers' educational profile, the engineering and nonformal programmes currently available and the institutions constitutes the exploratory facet of the situation analysis. The situation analysis, however, extends into the possibilities – envisaged situation – focusing on the aim of the study. Each aspect incorporates a number of notions, attributes and features to be examined and interpreted for a better understanding of the situation. The examination and interpretation of these aspects and the situation is conducted with a mixed-method empirical investigation.

5.2.3.2 Research sample

All 50 Engineering Faculties at FET colleges of South Africa were targeted because they are regarded as a "last resort" for unsuccessful school leavers (Department of Education, 2007b:5). Within the college structure, Engineering Faculties were selected to reduce the range of the study to one specific field. "In order to obtain representativeness, the sampling plan needs to exist in dialogue with field incidences, contingency and discoveries" (Gobo, 2004:436). That was taken care of by the population assembly of engineering learners and the distribution of colleges across the country. From the college personnel, heads of faculty and senior lecturers were selected depending on the availability of the personnel. Faculty heads and senior lecturers are lower level management staff with direct involvement, experience and perspective on the situation of the learners concerned, unsuccessful school leavers. Heads of faculty also have access to the records of FET colleges.

A target population was "identified": senior personnel, preferably engineering faculty heads and learners at engineering studies faculties of FET colleges. Learners in engineering at FET colleges were selected as a relevant cohort (subject of study) because it was established that unsuccessful school leavers regard FET programmes at the colleges as a last resort in further education and engineering is the selected educational field of the study (cf. 1.1). Each engineering faculty at the colleges was assigned the privilege to randomly select a group of 30 learners for voluntarily participation. Thirty learners fit easily into an average sized classroom and more groups per college would involve more personnel putting more pressure on their tight schedules, creating the possibility of discouraging colleges from participating. The probability of non-representativeness by poor selection at a few colleges would be neutralised by the effect of 1 500 learners at 50 colleges.

All of the 50 FET colleges in South Africa were approached, permission requested to do research and participation of the Engineering Faculties motivated. Reminders were sent and phone calls made in an effort to encourage participation. Personnel shortage and tight schedules were given as the reasons for non-participation by the colleges who declined the request.

Colleges from all 9 provinces and ranging from small to large, in terms of learner numbers, participated in the research. They represent approximately 115 000 learners with an estimated 46 000 (calculated from information of the Department of Higher Education and Training, 2009:17-20) in engineering: about 29% of all the learners in engineering studies at FET colleges, countrywide. The participating colleges in the respective provinces are listed in Appendix I.

Sixteen faculty heads at 16 colleges participated in the questionnaire round of the research. Twenty-five faculty heads and senior personnel participated in the interviews considering the notion by Holland and Campbell (2005:59) that "...benefits accrue continuously in relation to the number of interviews carried out". Sixteen returned FET college and 409 learner questionnaires were recorded and analysed.

Permission was granted by FET colleges' management to do research at the colleges. A brief motivation for the research accompanied the questionnaires, complemented by a short description of the procedures and time schedules. Once permission was granted, arrangements with the personnel could be made. A stamped return envelope formed part of every parcel. All the respondents needed to do, was to complete the questionnaires, put them in the return envelope and mail them. Every effort was made to ensure responses and easy return of the questionnaires.

A follow-up letter, carefully drafted and edited, was another instrument to encourage colleges to participate in the research. Colleges that responded received letters of thanks and encouragement for further participation. Some of the more interesting "discoveries" were revealed to incite curiosity in the study.

5.2.3.3 Quantitative survey

The convenience, logistics and cost of questionnaires made it a very attractive option despite possibility of poor response (Neuman, 2000:266). The 50 colleges targeted are scattered all over the country making questionnaires a convenient research tool for determining and establishing a basis for further investigation. Mailing the questionnaires to the colleges was considered the most feasible option. Creswell (2008:395) regards questionnaires a "convenient way to reach a geographically dispersed sample of the population." Colleges that did not respond were reminded by letter followed by phone calls.

5.2.3.3.1 Questionnaire development

Developing a questionnaire requires determining the main areas within the broad frame of the research goal, using the research question and objectives as guidelines when defining the framework. A number of specific questions, associated with each heading, was grouped under these headings bearing in mind the kind of research and the objectives involved (Robson, 1993:249). Appropriateness of the questions under each heading and the purpose of each one should contribute towards accomplishment of the objectives. The objectives were derived from the research question and subsidiary questions.

A descriptive title followed by clear descriptive subheadings signifies the purpose of the questionnaire and questions. Further motivation and elucidation are done in the questionnaire introduction, accompanying questionnaire guide and introductory letter. The questionnaire should speak for itself. Self-explanatory subtitles were used to enhance comprehension of the purpose of the exercise. Clear and concise guidance was employed to further improve the chances of a useable contribution to the exercise.

To further develop understanding and motivate participation an introduction and instructions were added and the purpose explained. The same applied to the subdivisions. The "what-how-why" of the exercise was made clear in the questionnaire introduction, accompanying questionnaire guide and introductory letter to ensure comparable reliable responses and an attempt was made to achieve that. All the questionnaires were accompanied by a guide, elaborating on the individual questions to enhance understanding.

According to Creative Research Systems (2006) a variety of questions are utilised in questionnaires: multi-choice, rating, agreement (Likert) scales, numeric open-end and text open-end questions. However, the questions and statements of the questionnaire limit the responses to rating, Likert, multi-choice and nominal scales and open-end questions. According to Cox and Cox (2008:19) items requiring the same type of response should be grouped together. This was only attempted within divisions of the questionnaire. Determining statistics, facts and opinions requires utilisation of more than one type of question and/or scale. Routing questions are not considered because they complicate filling in of the questionnaire and may reduce the number of responses.

Some desired information could not be obtained with scales having predetermined answers confining the responses to these limitations. It was therefore essential to add open-end questions, allowing the respondents room for a virtually endless variety of possibilities only limited by the relevant field or construct. Burgess (2001:8) gives an example: "... open questions [are] ... (that) would elicit a whole range of replies of varying length and articulation." It is evidently possible to broaden the scope of questionnaires by adding a qualitative feature to it in an attempt to acquire specific information beyond the reach of limited scale questions and elucidate the relevant issue.

Open-ended questions and ranking scales enable interpretation of the respondents' perceptions of the situation (Patton, 2002:21). Even so, the number of open-end questions was restricted to the essential that enables understanding and appreciation of the experiences of the respondents. Cox and Cox (2008:18) posit that open-ended questions should only be included after careful consideration and be limited. Careful consideration of the subjective data needed to enhance the interpretation, will help to narrow down the number of these questions.

Clarity, comprehensiveness and acceptability – which are norms of the exercise – can be pursued by piloting (Rea and Parker, 1997:28). A pilot enquiry was conducted as a pre-test to establish the "atmosphere" and to obtain an appraisal of the planned questionnaires and interviews. According to Arsham (2011:2 of 20) "...a small "pilot sample" is used to test the data-gathering mechanisms and to get preliminary information for planning the main sampling scheme." Some restriction actually applies to the entire questionnaire. Questions that do not fully contribute to a better understanding of the study should be discarded (Gillham, 2004:5). After evaluation and interpretation of the pilot-questionnaire responses, feedback and the necessary adjustments/corrections, the research instruments were considered appropriate and practicable.

A true reflection of the learners' educational situation and a genuine fair educational profile of the learners were reliant upon the authenticity of the responses. However, inconsistency in the responses among the colleges could reveal inaccurate data (Neuman, 2000:171). The image of the learner or the picture portrayed by the questionnaire should be constant throughout. Considering these guidelines a procedure was followed to develop appropriate questionnaires (Appendix A; Appendix B).

Open-ended questions are used in sections A and D in an endeavour to confirm/reject the assumption of unsuccessful school leavers studying in engineering at FET colleges, compile a list of practicable prospective skills programmes and add to the justification of alternative education for unsuccessful school leavers. These questions were also attempts to determine commendable enterprises and appropriate education for entrepreneurs. Open-ended responses are categorised and listed.

Each division of the questionnaires has specific constructs fundamental to the related questions/statements (Appendix G; Appendix H). Lists contain the division headings, constructs and question/statement codes are recorded in Appendix A. Personnel and learner questionnaires correlated only on aspects learners could make significant contributions to.

The responses to these questionnaires were computer-analysed and the frequencies determined. Frequencies were regarded sufficient to obtain the information required to substantiate the educational situation of unsuccessful school leavers in engineering studies at FET colleges. Validity and reliability are attainable with the complementary data and consequential inferences made from the interviews, literature, official statistics and reports. The inferences made from the questionnaire data supplement the knowledge base and reinforce the capacity required in the design of the envisaged curriculum and concomitant education.

The questionnaires provided space for comments at the end, as respondents might have more to contribute to the research than the questionnaire allows. If the opportunity is not offered, information valuable to the enterprise may be lost. They were invited to comment and provide further information that could enhance conceptualisation of the educational situation of unsuccessful school leavers.

Special measures were taken to obtain the best possible response rate. The questions have personal relevance to the selected sample of respondents because they are involved in education at the engineering faculties of FET colleges. Unsuccessful school leavers' poor examination successes concern FET college personnel because they are expected to improve the situation. Skills development is partly the responsibility of FET colleges in initiating and developing the foundation stages of proficiency. Faculty heads and senior personnel were selected because they have the experience, knowledge and access to the desired information.

Confidentiality was guaranteed with the suggestion that contact details could be provided separately. The promise of a copy of the research results may have persuaded some colleges to participate in the research (Creative Research Systems, 2006).

5.2.3.3.2 Data processing – Analysis outline

The constructs and questions are coded to facilitate referencing and avoid confusion. The codes are straightforward "P" for personnel and "L" for learners followed by the division codes and question numbers. Interview responses are labelled "I" and the interviewees are assigned a letter of the alphabet at random. Removing the open-ended question responses from the other responses for compilation of the frequency tables is a practical consideration enhancing data capturing. They are interpreted and categorised according to the different perspectives revealed.

A computer programme is used to determine the frequencies of the responses in an attempt to assign significance to the selected constructs. The data give a reasonable picture of the educational situation of unsuccessful school leavers, but it is further investigated by means of interviews with faculty heads and senior personnel at FET colleges and judged against the official statistics. Validity and reliability are determined through triangulation. The qualitative facet is incorporated in the research to elucidate the picture of the educational situation of unsuccessful school leavers.

The qualitative and quantitative research approaches are combined to produce the desired outcomes – providing the needed information as suggested by the research question, to accomplish the aim of the study (Gilbert in Holland and Campbell, 2005:141; Holland and Campbell, 2005:21–26).

Consistency within the individual questionnaires was checked and dealt with accordingly.

Comparing the data of the questionnaires, official statistics and interviews after analysis and interpretation is a step in the process of determining validity, reliability and credibility. Together with the other collected information from literature, reports, statistics and interviews, the data will be dealt with in the discussion of the research report.

5.2.3.4 Qualitative inquiry – Interviews, telephone and Skype interviews

A qualitative facet is added to the empirical research to improve understanding of the situation of unsuccessful school leavers, which is regarded more comprehensive than could be established through quantitative means alone. The quantitative evidence verifies the situation to be elucidated by the inferences on the qualitative data and a combination from the different facets of the research. Qualitative data affords an opportunity of evaluation of the situation from the perspective of the interviewees. "...[K]nowledge could be acquired through the eyes of people who experienced it" (Du Plooy, 2002:30).

A more holistic perspective of reality (the educational situation of unsuccessful school leavers) can be accomplished with a qualitative investigation. Best and Kahn (2003:243) mentioned "***student characteristics relevant to learning*** and the study of ***qualities that make for successful schools***"[5] as two "research issues" that could benefit from the holistic approach. These two "issues" signify the inclusion of qualitative research as complementary follow-up facet to enhance conceptualisation. "Student characteristics relevant to learning" are called "education profile" of learners in this study.

5.2.3.4.1 Interviews

Interviews, telephone and Skype interviews with faculty heads and senior personnel of engineering studies at FET colleges are included in the investigation to complement the other instruments utilised. Telephone and Skype interviews were considered because the colleges are scattered around the country, which poses logistic problems. These interviews were also utilised to establish relationships and confidence in regard to both the interviewer and the interviewee.

Open-ended interviews were found to be more suitable for the purpose of this study than structured interviews considering elaboration on data acquired from official statistics and questionnaires. Consequently only open-ended interviews were conducted. The delicacy and complexity of the open-ended interview planning, execution and analysis are fully appreciated

[5] Author's accentuation.

(Neuman, 2000:272-282). Extensive exploration of the experiences, knowledge, perceptions and perspectives of faculty heads and senior personnel at engineering studies of FET colleges were facilitated (Maree, 2010:87).

The objectives of the research (cf. 1.4.3) were pursued without confining the interviews to the framework, allowing relevant discussion and the discovery of new information. Information relevant to education is not "off limits" and was allowed. A broad framework was given as mind preparation and outline for the discussions to follow. Learner educational profile, learning preferences, most appropriate education for unsuccessful school leavers and educational institutions for offering the envisaged education serve as framework for the interview guide, backed up with probing questions. Relevant probing questions were drafted to stimulate and guide the open-ended personal, telephone and Skype interviews.

The interviews were conducted to the best of the ability, and as closely as possible to the guidelines discussed. In the 16 participating FET colleges, 21 interviews were conducted. Communication was open, friendly and honest. Genuine concern and dedication of the participants were evident. All the information was recorded, transcribed, processed, interpreted, analysed and relevant data identified.

It was not possible, regarding the scope of the study, to limit telephone interviews to the suggested ten minutes, with 30 – 45 minutes for personal interviews (Apostol and Irvine, 2003). Confining the interviewees to the guidelines presumed by the objectives of the study would have limited the information acquired. Considering the educational situation of unsuccessful school leavers in engineering studies at FET colleges, the interviews reveal serious concern of the personnel resulting in spontaneous reflection. The duration of the interviews was one and a half to two hours, but the additional time was most certainly worthwhile. Much more was achieved than only the predetermined objectives.

Open, friendly interviews were conducted in a relaxed atmosphere and the information conveyed was beyond expectation. It complemented the questionnaires and added information revealing more about the situation of unsuccessful school leavers than the intended scope. A better understanding of the unsuccessful school leavers' situation was achieved, questionnaire data substantiated and suggestions given for the envisaged unsuccessful school leavers' curriculum and education.

Attributes of the questionnaires, educational profile of learners, appropriate education for unsuccessful school leavers and suitable education institutions, were included also for the sake of triangulation. Together with the direct statistics and other documentation, validity and reliability of the questionnaire responses can be determined and vice versa (Neuman, 2000:125).

Analysis already begins during an interview. Perceptions formed during the interviews contribute towards the concepts, themes and patterns emerging from the information provided (Rubin and Rubin, 1995:226). Providing insight and perspective, this "preliminary analysis" shaped and improved the review design with new ideas and concepts. Every following interview was an improvement on the previous one, thereby improving on the responses without changing the framework.

5.2.3.4.2 Interview data processing

The interviews were transcribed and labelled/coded. Summarising the transcriptions as suggested by Holland and Campbell (2005:65) facilitated detection of significant information. Significance gets precedence over occurrences, reiterating the interpretive feature of this facet of the research. In careful contemplation of the information pertinent patterns, trends, occurrences and significant comments were detected.

The information is differentiated into themes and subheadings of the draft analysis and the relevant information organised and classified under the headings of the analysis framework developed in the process. The patterns that developed enable categorisation of the information into specific concepts, experiences, interpretations, attitudes and beliefs correlating with the objectives of the study (cf. 1.4.3). Further classification is done with regard to similarities and differences (Best and Kahn, 2003:259). The significance of the differences and similarities reflects in the relevant topics of the report indicated in the outline of differentiated information (Appendices C).

Correlation between the qualitative and quantitative data is evident from the outlines (Appendix A, B and C). Items of specific interest are educational profile of learners, appropriate education, learning preferences of learners and institutions for unsuccessful school leavers' education. Upon these items, supported by the remaining data and correlation with other facets of the research, literature, official statistics and questionnaire data, an argument for specific education for unsuccessful school leavers could be built. Concurrently, credibility of the research could be established.

Determining validity and reliability in qualitative instruments is difficult because interpretation and evaluation – qualitative features – are difficult to substantiate, but with comparison of quantitative and qualitative data, cross-references and checks, it is possible (Best and Kahn, 2003:276). The interviews substantiated the inferences made from the questionnaire data, literature and statistical data.

5.2.3.5 Triangulation procedure

The constructs of the questionnaires are tabulated and correlated with the tabulated themes and subheadings of the qualitative data. Inferences made are compared with the official statistics and literature information where applicable in the process of constructing a representation of the educational situation of unsuccessful school leavers. From these deductions information, norms and criteria for the envisaged curriculum and concomitant education are formulated. Detailed discussions are reported and triangulation applied in the situation analysis in division 5.3 below.

Primarily positive correlation and similarities confirm the educational situation of unsuccessful school leavers and provide answers to the research questions and objectives. Furthermore, personnel questionnaire responses, interview data, official statistics and literature correspond on the basic educational attributes ascribed to unsuccessful school leavers (SACMEQ II, 2000 and III, 2007; Department of Education, 2009:87 (TIMMS); PIRLS 2006 in Van der Berg et al, 2011:4). However, more detail is provided by the interviewees, substantiating specific attributes, elaborate on some and exceed the confines of the questionnaire responses.

Personnel questionnaire and interview data correlate on the (un)appropriateness of engineering education at FET colleges for unsuccessful school leavers, the most suitable educational approach and the place of entrepreneurships in the envisaged curriculum. Support is also apparent in the literature as indicated in the inferences in 5.3.

Learner questionnaire data correlate with interview responses on school grade, support entrepreneurial aspects and provide information on learning barriers and preferences valuable to elaboration on fundamental learning theory and educational strategies. Contradicting the educational attributes of learners is not unexpected considering the educational situation of the learners and absence verification. Learners' perspectives on their educational situation enhance the inclusive picture of unsuccessful school leavers in engineering studies at FET colleges.

Triangulation was applied throughout the inferential process. The empirical research substantiates the situation revealed by reports and statistics on education and the FET school and college examination results. Adding the mentioned information to the statistical evidence and literature content consummates the knowledge base of the study.

5.3 SITUATION ANALYSIS – EDUCATIONAL SITUATION OF UNSUCCESSFUL SCHOOL LEAVERS

The situation encompasses the learners, education and prospects in the scope of this study with the prime concern being their ability to learn effectively. Without negating psychological, personal and socioeconomical circumstances, the focus is on the educational aspects common to the majority of unsuccessful school leavers. These aspects can be addressed in group-context by establishing the basic attributes to their poor record of learning and providing the means, mode and manner for effective learning. They could not cope in school and FET college engineering programmes because they did not learn adequately. The reality of unsuccessful school leavers – school dropouts – is established, but detail is needed to analyse, interpret and comprehend the full extent of their educational situation.

Establishing a realistic presentation of the educational situation of unsuccessful school leavers from the inferential data is done according to the outline given in 3.4.2. Covering the different aspects by integrating data from the different facets of the research is an attempt to provide credible comprehensive information for the curriculum design and applying triangulation.

5.3.1 UNSUCCESSFUL SCHOOL LEAVERS – AGE AND QUALIFICATIONS

Being the principal constituent in the equation a fair educational profile of the learners is essential in understanding the educational situation of unsuccessful school leavers. The sample from the target population of unsuccessful school leavers are learners who resort to FET college engineering studies as a last chance in further education. Leaving school during the period from Grade 9 enrolment to matric examinations, they are unsuccessful in completing school – achieving matric certificates. They need a second chance in education to improve their skills and qualifications and thereby their prospects (Van der Berg et al, 2011:3, 9).

Determining the age and highest school grade of these learners provides a measure of comparison with school grades and initiation of the "profile" or attributes inquiry essential to the process.

5.3.1.1 Age of unsuccessful school leavers

The age of the learners ranges from 15 to 22 according to the personnel respondents' data, which correlates with the school levels of unsuccessful school leavers reported by the interviewees: Grades 9 to 12. It also corresponds with the major school dropout period: Grade 9 to Grade 12. Papier (2009:20) found the majority of learners in 2007 and 2008 in the Western Cape at FET colleges to be between 15 and 20 years of age at first enrolment.

Although the intention should be to keep learners involved in education or re-engage them as soon as possible after leaving school, the envisaged education should be available to all young people, including NEET young people most probably in differentiated format to cover interests and aptitudes.

5.3.1.2 School qualifications of unsuccessful school leavers in engineering at FET colleges

Determining the school qualifications of learners in engineering studies at FET colleges is problematic because FET colleges do not record the qualifications of new entrants. The only sources were the personnel, learner respondents and the interviewees. No official or FET college data on school qualifications could be obtained. Considering the learner questionnaire data and the interview responses, it can be concluded that the school qualifications of unsuccessful school leavers range from Grade 9 to Grade 12 including unsuccessful matriculants and the occasional matriculants without matric exemption. Although compliance with the minimum requirements of 15 years of age and Grade 9 is compulsory for the enrolment of learners, FET colleges prefer to enrol Grade 12 learners. The general notion is that Grades 11 and 12 learners do better in NC(V) programmes:

- "The Grades 11 and 12 students do better" (Interviewee D).
- "The entry level is raised to Grades 11 and 12. Grades 9 and 10 only in exceptional cases" (Interviewee A).
- "Grades 11 and 12 students are the students that we have to enrol because they do better while the other students are struggling"[6] (Interviewee C).

The school qualifications of new entrants in engineering studies reported, confirm the status of the majority of learners in engineering at FET colleges as unsuccessful school leavers. They do not qualify for higher education and have to compete with better-qualified learners in learnerships, apprenticeships and other occupations, exacerbating their unfavourable situation. The tendency of FET colleges to enrol Grades 11 and 12 learners is not a solution to the problem and would exclude Grades 9 and 10 learners from further education. However, NC(V) and NATED programmes are not regarded appropriate further education for unsuccessful school leavers (cf. 2.3.2.2; 2.3.2.3).

Compulsory enrolment of all learners aged 15 and older with Grade 9 minimum qualification, renders recording of school qualifications insignificant. Reasons for not recording of school grades by FET colleges, mentioned by the interviewees, are the workload of personnel and personnel shortage. Recording of valuable statistics can however be accomplished with

[6] Translated from Afrikaans.

applicable computer programmes. Establishing patterns in poor NC(V) results related to school qualifications is not possible without reliable recording of previous achievements.

5.3.1.3 Reasons for enrolment in engineering at FET colleges

From the literature and official statistics it can be concluded that unsuccessful school leavers who want to improve their qualifications, resort to vocational education at FET colleges (Department of Education: 2007b:5; RSA, 2008:19). Learners enrol in NC(V) engineering programmes for dubitable reasons, often oblivious of programme purpose, content, standard and range. This aspect of the situation, revealed by the responses and interview data, can leave them poorly motivated and often disillusioned.

Reasons for enrolment in engineering at FET colleges given by the personnel, in response to an open-ended question and in the interviews (B, C, E, F, H, J, M, N, O, Q, and U), can be summarised as:

- Poor academic performance at school:

  "Most failed Grades 11 and 12 at school."

  "Cannot cope with programmes at school."

  "Learners cannot cope in the academic environment of schools. Current results confirm this."

  "A lack of qualifications prevents them from going to other institutions."

  "They enrol at engineering in hope of attaining an NQF level 4 certificate."

- Financial considerations:

  "Lower cost and bigger range of courses."

  "Bursaries available, is a great motivation."

  "They get financial support and they do not need to attend school" (college classes).

- Career guidance:

  "They are told to come to FET Colleges."

  "Career guidance personnel at schools refer learners, performing poorly in math and science, to FET colleges."

  "Learners are told that they have to go to FET colleges because there they can get practical training."

- Interested in engineering fields:

  "They want to study in the electrical and mechanical engineering fields."

  "Job opportunities with the engineering field qualifications are better."

"To get skills that they may not obtain in academic education."

"Learners want to become tradesmen (artisans)."

- Improve employability/Obtain an occupational qualification:

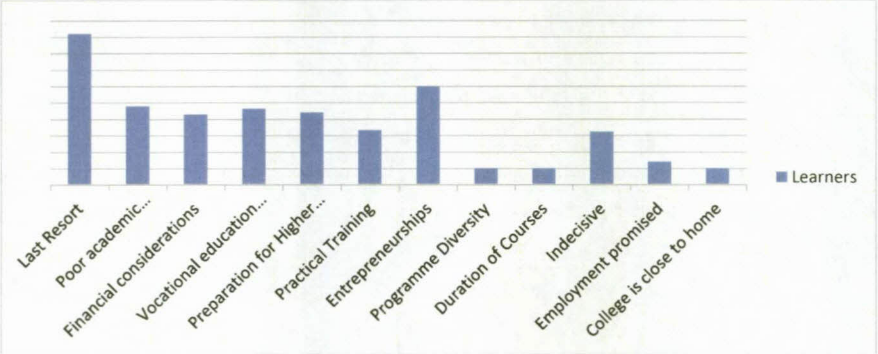
  "Improve employability."

  "The need for a relevant qualification." (A relevant qualification is one with good employment prospects.)

The reasons for unsuccessful school leavers to enrol in engineering at FET colleges, given by college personnel respondents, correlate with interview data. A very significant reason, poor academic performance confirmed by the official statistics, feature also in the discussions about educational foundation and preceding education. Inadequate educational foundation, demonstrated by poor language, mathematics and science proficiency, hampers progress in the engineering programmes at FET colleges.

Learner responses, on an open-ended question why they enrol in engineering at FET colleges, are given in Graph 5.1. Although quantification of these responses, being open-ended, is not of prime concern, they portray learner perceptions.

Graph 5.1: Learner reasons for enrolling in engineering at FET colleges



Questionnaire LA. 16.

Correlation of the learner responses and reasons given by interviewees are significant in the following:

- Poor academic performance at school, which include "Last Resort (nowhere to go)" in the learner responses
- Financial considerations feature significantly
- Interested in engineering fields and entrepreneurships reflect positively on career guidance
- Career guidance also reflects in practical training and indecisive responses

School career-guidance personnel refer learners, encountering problems in mathematics and science, to FET colleges to enrol in NC(V) engineering programmes oblivious of the fact that these two subjects are compulsory and the standard of NC(V) mathematics is higher than that of school mathematics (cf. 2.3.2.3). Learners are often referred to FET colleges "because at FET colleges learners do practical training". It can be concluded that learners who cannot cope in the linguistic-logic-mathematical predilection of schools are referred to FET colleges regardless of learner aptitudes, FET college programme content, standard, range and the consequences for learners. FET colleges do not have programmes to accommodate these learners (unsuccessful school leavers) effectively. This practice presumes that some school career-guidance personnel are not well informed about FET college programmes and applicable future occupations.

A strong consideration, financial reasons, is addressed by the authorities, but the bursaries available for FET education should not be awarded at random. Psychometric and aptitude tests can predict learner progress and should be compulsory for learner placement, but from the interview data there is no evidence of consistent application thereof.

"I do not agree with schools that drop these students. The mandate of FET colleges is to enhance progression in terms of teaching and learning – to prepare learners for specific occupations. These learners should be regarded as students like any other students in the country who need space to progress in terms of academic activities. It is not acceptable to regard these students as dropouts and refer/channel them to FET colleges because that is a sector that does hands-on or practical activities and these students can do practical more than theory. All providers of education must be willing and must be in a position to accept these students" (Interviewee S). Every educational institution should accept responsibility for its own remedial education. What went wrong in an institution must be corrected at that institution. Passing it on to other institutions is burdening these institutions with facets of education, which they are not catering for and which is probably outside their fields of expertise.

However, education specifically designed for unsuccessful school leavers can change the situation because, equipped with these curricula, FET colleges will be capable of addressing these educational needs. The envisaged education for unsuccessful school leavers can afford schools the luxury of referring learners, who do not respond well in the linguistic-logic-mathematical predilection of mainstream school education, to FET college "second chance" education. Adding facilitation of bridging to the "second chance" education design will render re-entry into mainstream vocational education feasible.

The expectations of the learners are revealed in the responses given. Considering the examination results of engineering studies at FET colleges, learners should have been disillusioned. Learners are very poorly informed about the engineering programmes at FET colleges and their further educational and employment prospects. FET colleges do not have educational programmes to accommodate learners who do not respond well to the linguistic-logic-mathematical predilection of mainstream education. They are referred to FET colleges or drop out of school and resort to FET colleges just to face more demanding education with a higher standard in mathematics.

5.3.2 EDUCATIONAL FOUNDATION OF UNSUCCESSFUL SCHOOL LEAVERS

An essential consideration, underlying the education for unsuccessful school leavers in engineering studies at FET colleges, is their educational foundation. Educational foundation is of paramount importance to any effort in skills development and improvement of knowledge and qualifications. The quality of preceding education and development of key attributes are educational factors fundamental to educational foundation.

5.3.2.1 Quality of preceding education

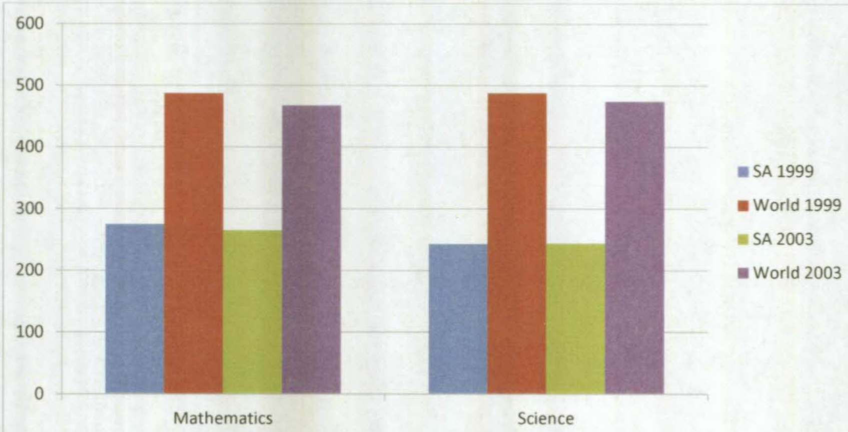
The quality of the preceding education is questioned in the literature consulted. Van der Berg et al (2011:3) report that, "Despite reforms, education quality remained disappointing." The correlation with the interview responses is evident. Official statistics confirm the notion of low-quality preceding education putting unsuccessful school leavers in an educational dilemma. This dilemma is confirmed by the poor success rate of learners in engineering at FET colleges, questionnaire data on educational performance and the interviewees.

"At school they [unsuccessful school leavers in engineering studies] do all their subjects at lower level" (Interviewee D). This comment is substantiated by the notion that poor performers are referred to FET colleges (cf. 5.3.1.3), poor quality education is reported by Van der Berg et al (2011) and also by the Department of Higher Education and Training (2010). "The learners have Grade 9, but the standard is too low for entry into NC(V) 2" (Interviewee D). These notions are supported by interviewees U and I, who posit that school qualifications are not substantiated by the competences presumed and "the standard of unsuccessful school leavers is about Grade 8 regardless the level achieved".

"The effectiveness of post-school education depends heavily on the quality of the schooling experience that young people bring with them from ordinary schooling. Internationally benchmarked tests show that the quality of South African schooling lags far behind levels of achievement in other national systems" (Department of Higher Education and Training, 2010:16;

Graph 5.2). Concluding that further education is difficult – if not impossible – for unsuccessful school leavers with the level of competence achieved at preceding education, is validated by the evidence provided.

Graph 5.2: Average score in the TIMSS 1999 and TIMSS 2003 Grade 8 mathematics and science achievement tests



Source: Department of Education (2009:87) – Table 60, DHET (2010:18)

The standard of NC(V) engineering programmes makes vocational education a daunting task for unsuccessful school leavers. They need education, focusing on construction of a sound educational foundation aligned with the entry-level requirements of these programmes: NC(V), learnerships and apprenticeships. Poor levels of proficiency are portrayed by reports of poor performances of South African learners in the international arena.

5.3.2.2 Inadequate educational foundation

Ability to learn and mental capacity of unsuccessful school leavers is underdeveloped (Interviewees U, P and G). In support of this conclusion, Van der Berg et al (2011:3) report alarmingly low levels of cognitive achievement in key learning areas such as reading, mathematics and science. Unsuccessful school leavers need appropriate quality educational to build a profound educational foundation encompassing the declarative and procedural knowledge required for the specific further education they intend to pursue. Correlating with the official statistics and literature information, the educational capacity of unsuccessful school leavers mentioned, renders them very few opportunities in education and poor employment prospects. A sound educational foundation needs to be constructed upon the key learning areas of language, mathematics and science proficiency.

"In the Trends in International Mathematics and Science Study (TIMMS) of 2002, South African Grade 8 students achieved the lowest average scores in both Mathematics and Science out of 46 countries, including six African countries. More recently and at the primary school level, South Africa came last out of 40 countries in the Progress in International Reading Literacy Study (PIRLS 2006)" (Van der Berg et al, 2011:4). "In the Southern and Eastern African Consortium for Monitoring Education Quality surveys of 2000 and 2007 (SACMEQ II and III) South Africa performed slightly below the average of the other participating African countries in Grade 6 Mathematics and Reading, despite benefiting from better access to resources, more qualified teachers and lower pupil-to-teacher ratios" (Van der Berg et al, 2011:4). These reports suggest inadequate development in these fundamental subjects from a very early stage.

Unsuccessful school leavers lack the educational foundation to succeed in further education on the NQF 2 level (Interviewees M, N, P and S). Matric and NC(V) are unachievable unless their educational foundation can be improved substantially before attempting further education. Special attention should be given to language, mathematics and physical science, subjects fundamental to further education in engineering.

Unsuccessful school leavers need special "second chance" education to build a profound educational foundation encompassing the declarative and procedural knowledge required for the specific further education they intend to pursue or alternative prospects in employment and self-sufficiency.

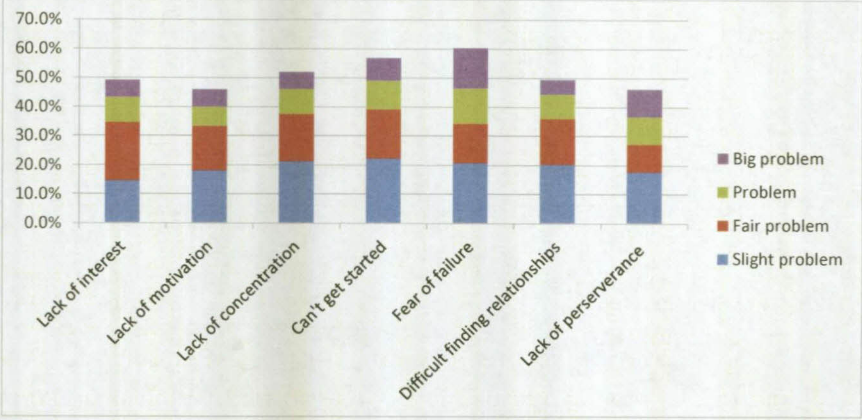
5.3.2.3 Learning barriers

Interviewees mentioned that learners "battle with NC(V) learning content," the standard of the subjects is too high, they are unable to cope with maths and science and cannot "learn on their own" (Interviewees P, N, D and G). Interviewees' (I, N, R and T) notions that learners "have no learning attitude", "it is difficult to 'reach' the learners", "lack of interaction", "learners do not have a clue of what's going on in classes", "lack of (educational) maturity" and "low self-esteem due to lack of achievement" predict learning barriers that should have been addressed in preceding education, but are never concluded.

Inability to cope with maths and science was mentioned in the previous division. Learners who "cannot learn on their own" and "have no learning attitude" suggest lack of motivation, insignificance of learning content to the learners or inability to learn effectively, although not the only possibilities. "Difficult to reach the learners", "lack of interaction" and "learners do not have a clue of what's going on in classes" can primarily be addressed with a foundation of relevant internalised knowledge, mind preparation, attention attributes and presentation strategies founded on the level of communication proficiency of the learners. However, this does not represent the entire situation of learning barriers, shortcomings or possible counter measures.

Learner respondents are reluctant to reveal the true extent of their inability to learn effectively, but the frequencies substantiate the existence of learning barriers/shortcomings. Fear of portraying an "unfavourable" image may inhibit frankness about their inability to learn effectively. The reality of ineffective learning of these learners, beyond the confines of the learner questionnaire, can only be extensively established with psychometric tests and psychological research. The following frequencies (Graph 5.3) of the learner responses, in the context of poor educational results and interview comments, indicate the existence of learning barriers.

Graph 5.3: Learners' responses to learning barriers



Questionnaire LA. 4.

The learning barriers are important considerations for their future education in the institutions they deviate to, considered their last resort. Interviewees do not have any doubt about learners' abilities, learning barriers and shortcomings. The learners themselves are disenchanted with the educational opportunities available to them and find themselves out of their "comfort spheres" (Interviewees G and Q). Learning barriers, experienced by unsuccessful school leavers, should be comprehensively investigated to enable formulation of appropriate counter measures.

5.3.2.4 Lenient grade progression in preceding education

The grade progression policy of the schools is letting learners down. They are promoted without the concomitant competences their qualifications portray, putting them in contentious situations. "The pattern of high attainment up until grade 11 and low attainment of post-school education could be taken at face value to imply that the problems in South African education apply mainly at higher levels of education. In contrast, a more probable explanation is as follows: Low-quality education combined with high and lenient grade progression up until grade 11 means when a standardized assessment occurs, i.e. the Matric examinations, this serves to filter a large proportion of weak students out of further attainment" (Van der Berg et al, 2011:4).

Interviewee R confirms the situation: "The majority of the learners have Grade 10 and Grade 11 certificates that are worthless. The policy in the school grades is 'pass one pass all'." School grades do not vindicate the educational levels they are expected to represent (Interviewees P and N). Educators at higher grades and other institutions, e.g. FET colleges, are supposed to rectify the low-quality education offered in the lower grades, e.g. GET. Can FET colleges be blamed for raising the entry level to Grade 12? Providing quality education at school level, reducing school dropout and providing learners with adequate educational foundations for vocational education, is an essential facet of addressing the educational situation.

The other facet, providing "special education" to learners who do not respond well to mainstream education, is equally important. This study endeavours to propose education for unsuccessful school leavers, complying with the needs of these learners, in one field of education: mechanical skills.

5.3.3 ACADEMIC PERFORMANCE OF UNSUCCESSFUL SCHOOL LEAVERS

The educational capacity – ability to learn – of the unsuccessful school leavers in engineering studies at FET colleges is a major concern. This inability to learn effectively is revealed in the official statistics (their poor success rate in school and FET college education), personnel responses and the interviews. Examination results of the fundamental subjects, with the exception of Life Orientation, were below 50% in NC(V) 2 (Department of Higher Education, 2009:57–64; Graph 1.4).

5.3.3.1 Ability of unsuccessful school leavers to learn effectively

The ability of unsuccessful school leavers to learn effectively is questionable. Dropping out of school before achieving a Grade 12 certificate and their poor examination results in engineering at FET colleges (cf. Graph 1.1; Graph 1.4) suggest inadequate learning. FET college examination results are even worse than the school results and show a declining tendency (Graph 1.4). This tendency can be attributed to the "sifting process" eliminating better performers from the FET college engineering educational scene. Graph 1.4 confirms the existence of an unsuccessful school leavers' educational situation, lacking effective learning.

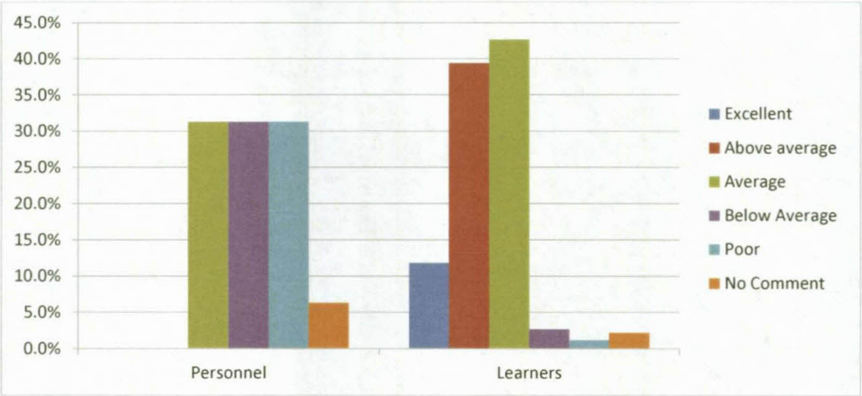
The better results achieved in NATED programmes are insignificant due to the limited scope and inappropriateness of these programmes (cf. 2.3.2.2). Real significance can only be revealed in the NC(V) programmes, but throughput rates distort the "success" rates. The low throughput rates indicated in Graph 1.3, Graph 1.5 and division 1.1.1 put the success rates in NC(V) in perspective. In 2007, 26 451 learners enrolled in NC(V) 2 and only 5 107 ended up in NC(V) 4 in 2009 regardless the lenient grade progression policy adopted. In mathematics, 1 596 and in physical science 114 learners enrolled on NC(V) 4 level. Bringing throughput into the equation, provide perspective on the NC(V) subject successes. The number of NC(V) certificates awarded reflects the real throughput (cf. 1.1.1).

Unsuccessful school leavers are unsuccessful because they did not learn adequately. Their current inability to learn effectively can be attributed to low-quality preceding education resulting in poor linguistic ability, poor comprehension and lack of learning strategies (Interviewee C). Low level of self-discipline, low self-esteem due to poor educational achievements and consequential lack of confidence in educational environments can also be attributed to low-quality prior education (Interviewees O and R). Poor linguistic ability and comprehension are discussed in 5.3.3.2. Different facets of effective learning, poor academic performance, educational foundation laid by preceding education, educational disposition of learners and learner cooperation are discussed in the following divisions.

Performance evaluation by the college respondents supports the notion of poor educational performance, and consequently poor results by unsuccessful school leavers, revealed in the official statistics and literature (Graph 5.4). No personnel respondent or interviewee considered an above average estimation. Learner respondents have a different view of the situation revealed in Graph 5.4, supported by their responses on an open-ended question. Reasons given for their choices by learners who regard themselves as average and below average correlates better with the statistics, personnel responses and interviewees than the learners with higher regards for their educational abilities.

The performance evaluation of unsuccessful school leavers in education reiterates their inability to learn effectively and emphasises their poor capacity in the subjects fundamental to engineering education, mathematics and science. Graph 5.4 compares the perceptions of personnel and learners on the theme of educational performance:

Graph 5.4: Educational performances of learners according personnel and learner respondents



Questionnaire: PA. 2; LA. 13.

Interviewees confirmed the poor performance of learners portrayed in the college questionnaire responses with additions to areas of weakness. This notion is substantiated by poor examination results (Graphs 1.1 and 1.3). Learners, lacking the fundamental attributes required for academic development, necessitate measures to address the educational situation of unsuccessful school leavers.

Without a sound foundation of linguistic-logic-mathematic capacity, learners are cognitively not competent to progress in the current engineering programmes (Graph 5.2). With learners lacking the fundamental abilities, it is not appropriate to enrol them in NC(V) regardless the aspirations of authorities, parents and learners themselves. Unsuccessful school leavers do not have the educational foundation for further education on the NQF 2 level.

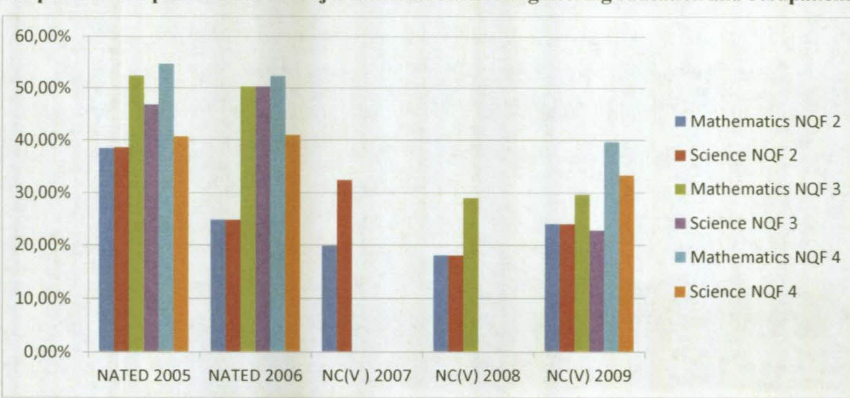
Learners with low academic potential will inevitably be included in the group of unsuccessful school leavers, but the question is why were they not identified earlier and rerouted to appropriate education? Learners from special schools for learners with low academic potential are also referred to FET colleges, but colleges do not have appropriate programmes to accommodate these learners (Interviewee G). They are enrolled in NC(V), oblivious of the standard and comprehensiveness of the programme content, with dismal results.

5.3.3.2 Performance of unsuccessful school leavers in subjects fundamental to learning

Psychometric tests, mentioned in interviews, reveal "*illiterate and innumerate*" Grade 11 learners (Interviewees G and U). Poor language proficiency (literacy) is regarded by all the interviewees as one of the major obstacles in the progress of learners. These comments are confirmed by Van der Berg et al (2011:4) and the Department of Higher Education and Training (2010:18). Papier (2009:7) came to a similar conclusion: "[L]earners who had been recruited especially in 2007 had not been the 'right' learners for these programmes. FET colleges' Marketing had targeted post-Grade 9 school leavers, thus attracting poorly performing school learners who saw college as an 'easier' option, and were woefully under-prepared for the demands of the new curricula, especially with regard to academic reading and writing skills, mathematical and language abilities." Overall linguistic inability in terms of communication, reading and writing contributes to poor comprehension, learning and verbal and written expression (reflection).

The examination results in maths and science (engineering science/physical science) at FET colleges in NATED and NC(V) programmes and the subject completion rates (Graph 5.5), incorporating subject dropout, reveal a situation unfavourable for educational foundation construction for engineering education. Correlating with the TIMMS, PIRLS and SACMEQ reports, it confirms the urgency to address the educational situation of unsuccessful school leavers and improve the quality of mainstream school education.

Graph 5.5: Completion rates in subjects fundamental to engineering education and occupations



(Department of Education, FET College Examinations: Results, 2006 – 2009)
(Department of Higher Education, FET College Examinations: Report, 2009:57 – 64)

Completion rate refers to the ratio of subject enrolments to examination successes.

Contrary to the literature information, official statistics and interviewees comments, 97,5% of learners respondents report excellent (42,5%), good (35,6%) to acceptable (19,4%) proficiency in reading (LA 3.1). Data on writing from the learner questionnaires reveal virtually the same perceptions: Excellent 39%, good 38,3% and acceptable 19,8% (LA 3.2).

The learners' perception of their proficiencies is unrealistic considering the "hard evidence," statistics and the interview inferences made. The conclusion, despite learner perceptions, is that unsuccessful school leavers lack proficiency in the key subjects.

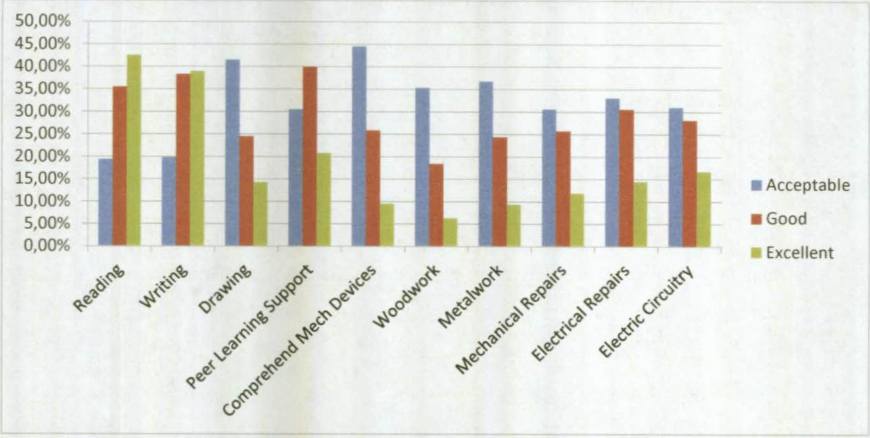
Interviewees are of the opinion that the learners lack numeracy, mathematic ability and math foundation. They are incapable of doing basic arithmetic (Interviewee G). In engineering education, mathematics is fundamental. Without a sound mathematical-linguistic foundation, learners do not have any hope of success in the engineering field except in lower-level skills occupations where profound knowledge in these subjects is not essential. Language, communication, mathematics, comprehension and insight are the fundamental attributes lacking in the educational capacity of the learners in engineering at FET colleges, recognised as unsuccessful school leavers.

Unsuccessful school leavers do not have the educational foundation to progress in engineering education at FET colleges. They lack proficiency in language, mathematics and physical science, the basic requirements to succeed in engineering studies at FET colleges. FET college personnel cannot do remedial and engineering education simultaneously. The standard of engineering education is completely underestimated by learners, parents, school educators, career-guidance personnel and authorities.

A different educational approach, initiating learning with hands-on activities, can be considered in an attempt to provide effective education to unsuccessful school leavers. In an attempt to investigate the possibility, two set of questions were asked regarding aptitudes and predisposition towards hands-on activities (LA 3; LA 7 – LA 11). The responses are positive towards the kind of education envisaged.

Graph 5.6 reveals a very moderate tendency towards practical education (training) substantiated by the interviews. Only the significant frequencies are shown in the graph.

Graph 5.6: Aptitude profile of learners – learners' perceptions



Questionnaire: LA 3

The aptitude profile of learners according to learners' own perceptions revealed in Graph 5.6 (Drawing to Electric Circuitry), although not excellent, indicates an aptitude towards practical (hands-on) work that can be exploited by the educational institutions. They are fairly moderate about their abilities. Their exposure to practical work in FET colleges' workshops should have some influence in their perceptions about their respective abilities. It is also interesting to note that they are confident about their ability to comprehend electrical circuitry and do electrical repairs than mechanical devices and repairs.

It is evident that the average unindentured engineering studies learner is an unsuccessful early school leaver (unsuccessful school leavers), leaving school for reasons disclosed in the interviews. In a report of the Eastern Cape Province Government (2004:2), as well as in RSA (2008:19) the assumption is substantiated that, in general, the learners in engineering studies at FET colleges are unsuccessful school leavers, resorting to vocational education as a last option.

5.3.3.3 Personnel respondents' perceptions of the aptitude profiles of unsuccessful school leavers

Aptitude profile enquiry is an attempt to disclose elementary strengths and weaknesses of unsuccessful school leavers. It is already established that they have poor mathematics, science and language proficiencies and therefore encounter poor educational progress due to poor learning attributes. An inadequate educational foundation, resulting from low-quality preceding education has far-reaching consequences for unsuccessful school leavers in any kind of education currently available to them.

Cap and other aptitude tests are administered at FET colleges, but the results are only to guide the learners in their choices (Interviewees G, H, N and U). Colleges can only advise learners regarding the best options; this resulting in randomly selected programmes (Interviewees G, F, R and P). Learners do not demonstrate interest or eagerness to enrol in engineering courses. They do not know which career they want to pursue and do not understand what they are embarking upon (Interviewees J and M).

Interview data, questionnaire responses, official statistics, and reports substantiate the conclusion that aptitude is not a prime consideration for the learners enrolling in engineering at FET colleges. School career-guidance personnel similarly ignore aptitude when advising learners regarding their future education. Interviewees C, M, E, F, N, B, O, L, J and D reported the following:

- "It is a last resort to attain a qualification."
- "They are forced to enrol at FET colleges because no other institution will accept them."
- "They do not have any place else to go."
- "Poor performance at school is the major reason for enrolling at an FET college."
- "They failed Grade 11 or Grade 12 and therefore resort to an FET college."
- "They prefer the greater freedom at FET colleges."
- "They just enrol to keep busy."
- "They lack the basics and basics required for engineering."
- "They lack the ability to progress in theory, but do better in practical."
- "Their parents decided that they have to enrol at an FET college."

Learners' (unsuccessful school leavers') educational capacities and aptitude profiles do not match the requirements of NC(V) programmes neither those of learnerships or apprenticeships (Interviewees B, G, J, L, M and N). "They enrol for no obvious reason with no distinct purpose", "they have no clue of engineering or engineering education", "they just enrol to stay in education" and "learners are reluctant to commit themselves to manual labour" are comments in support of the notion.

The NATED courses, as alternative education for unsuccessful school leavers, is not regarded appropriate and also do not address the educational needs of unsuccessful school leavers. They are outdated, do not comply with the minimum requirements of SAQA, are apprenticeship-specific and therefore useless to unindentured learners (Department of Education, 2007b:9; cf. 2.3.2.2). "The system is producing another legacy of unqualified people" (Interviewee H). Serious consideration should be given to an addition to the current educational structure of

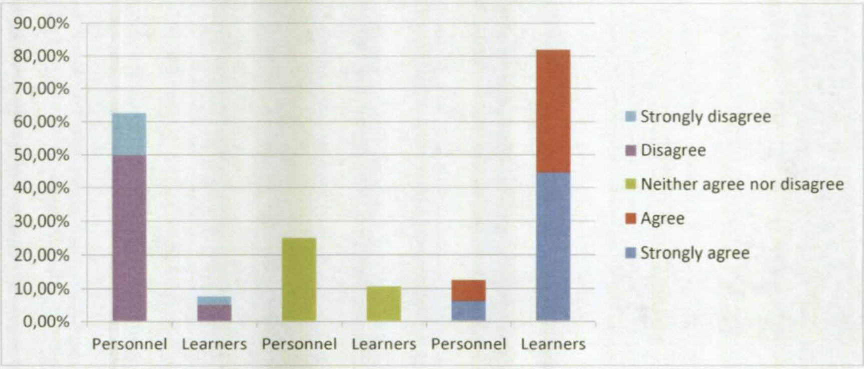
South Africa. Unsuccessful school leavers must be accommodated in an appropriate educational component to afford them further education.

5.3.4 EDUCATIONAL PREDISPOSITION OF UNSUCCESSFUL SCHOOL LEAVERS

Official statistics, personnel responses and interview data suggest learners' predisposition and responsibility regarding their own education as incompatible with effective education. Some learners enrol in engineering studies at FET colleges with the expectation that they will get practical training, get some kind of qualification, "go out, and earn money" (Interviewee E). Review data add ignorance, irresolution, negative predilection and misconception to learners' attitude towards their education. The downside of their educational scenario, however, is the reality of the situation – the everyday effectuation of their conception. Low pass rate, poor class attendance, irresolution, lack of cooperation, lack of dedication and disruptive behaviour reported by the interviewees, support the notion of laissez faire attitude and rashness (Interviewees D, F, G, I, J, M, O and U).

According to the interviewees, learners have little or no interest in the programme offerings. Career choice and enrolment are done randomly, most often irrespective of their aptitudes and interests. They do not have a vision or a plan for their future and they do not have any aspirations. Ignorance about the programmes and the related occupations can be attributed to poor career guidance, their predilection, lack of vision and dedication. They do not commit themselves to the courses in which they have enrolled (Graph 5.7).

Graph 5.7: Personnel and learners' perceptions on the suggestion that unsuccessful school leavers take responsibility for their own education



Questionnaire: PA. 3; LA. 6.

They did not live up to the expected sense of duty. The situation is symptomatic of an adverse educational situation of which poor results is the most prominent symptom. Educational scenarios are too complex to blame only one party in the partnership, but this is not about blaming anybody. A much more comprehensive research, focusing on learner behaviour and predilection in FET college education, will be necessary to understand all the aspects of the current situation. It is beyond the boundaries of this study, which is an attempt at offering an alternative educational opportunity for unsuccessful school leavers with a specific curriculum.

5.3.5 UNSUCCESSFUL SCHOOL LEAVERS' BEHAVIOUR IN EDUCATION SESSIONS/ LEARNING OPPORTUNITIES

Maintaining management in education by "preventing problems and keeping students engaged in productive learning activities", according to the Woolfolk (2010:431) recipe, is a good start in "maintaining a good environment for learning." A calm friendly atmosphere is conducive to effective learning, but to maintain it depends upon the role players and the circumstances. Although it is not a prime concern in this study, reporting learners' behaviour in engineering studies at FET colleges is necessary because it is a factor in the learning process and consequently in the results reported.

5.3.5.1 Lack of cooperation

Learners' lack of cooperation seems to be a factor in the education at FET colleges. Interviewees I, J, K and O are concerned about the laissez faire attitude of learners. They show little interest in learning anything, do not care about pass, fail or the outcome of their behaviour. Interviewee O mentioned a different behaviour in hands-on activities, which may be an indication of an appropriate educational approach for unsuccessful school leavers' education.

Learners are, according to interviewees I, J and K, frustrated by repeating subject levels at FET colleges already achieved at school. Papier (2009:21) supports this conclusion: "These learners were also frustrated at having to 'repeat' fundamentals that they felt they had done previously at school, and felt that they were 'going back' to Grade 9 level. Grades 9 and 10." The engineering examination results of the learners, supported by interviewees D, K and U point towards low standard of subject knowledge in subjects achieved at school, which correlates with the notion of low-quality education at school level reported by Van der Berget al (2011:13). This leaves FET colleges no other option than having learners repeat subject levels already achieved at school, regardless the frustration of learners. The purpose of vocational education is competence, which cannot be compromised.

Learners' poor educational achievements at school and in FET college programmes confirm the conclusion that they need second chance education to establish proficiency in the basics required to learn effectively. Their lack of cooperation can be addressed when offered education interesting and significant to them – engaging them because they need an educational foundation for further development.

5.3.5.2 Disruptive behaviour

Interviewees D, G, O and U are concerned about disruptive behaviour of some learners. They regard the misconduct of these learners problematic because it is difficult to maintain discipline and good classroom management, which are essential in any educational setting. Some of the learners, allegedly, try purposefully to disrupt educational activities and deny other learners the opportunity of "effective" learning. Interviewee O blames older learners, who are supposed to set positive examples and take up leading roles, of disruptive behaviour causing disciplinary problems and an unpropitious learning opportunity atmosphere.

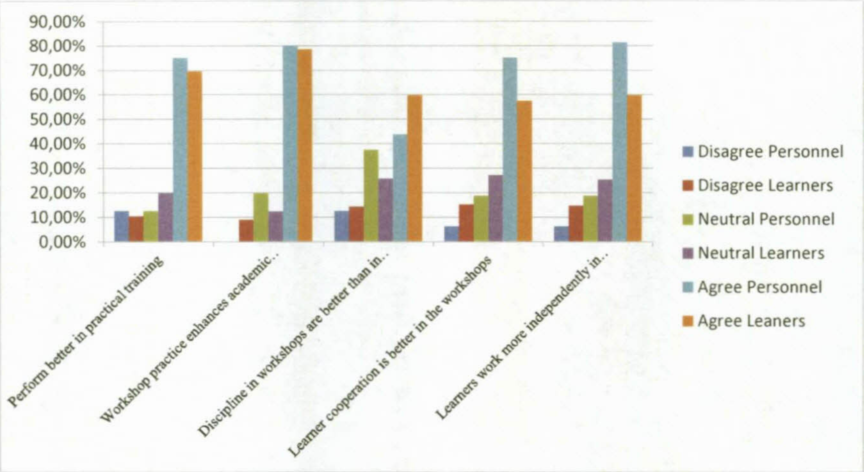
From these comments, it can be concluded that good education alone will not solve the problem. FET college personnel need disciplinary measure to counter such behaviour and authoritarian support to impose these measures. It is, however, preferable to prevent occurrences of disruptive behaviour, establish good communication with learners and utilise withitness (Woolfolk, 2011:432). Persuasion is preferable to coercion. Persuasion involves cooperation, but coercion is one-sided authoritarian enforcement of rules or prescribed conduct.

Enticing significant learning opportunities and projects may counter some unruly behaviour and afford opportunities to establish rapport with learners. This is, however, only one aspect in interpersonal communication in learning opportunity situations. Educators can incorporate a range of counter measures in their learning opportunity planning.

5.3.6 EDUCATIONAL APPROACH PREFERENCES OF UNSUCCESSFUL SCHOOL LEAVERS

Educational approach preferences of learners, revealed in the questionnaire responses, are in favour of practical training (Graph 5.7). Although personnel respondents do not always seem enthusiastic about engineering education, there is sufficient consensus to accept that personnel and learners, partners in education, will welcome practical hands-on education supported and consolidated with applicable knowledge. Respondents' opinion, supported by the interviewees, is that unsuccessful school leavers' education should include more comprehensive knowledge than required for calculated execution of tasks (Graph 5.8). The conclusion is practical training supported by integrated knowledge beyond the confines of trade theory.

Graph 5.8: Educational preferences of learners in engineering studies at FET colleges according to personnel and learner respondents



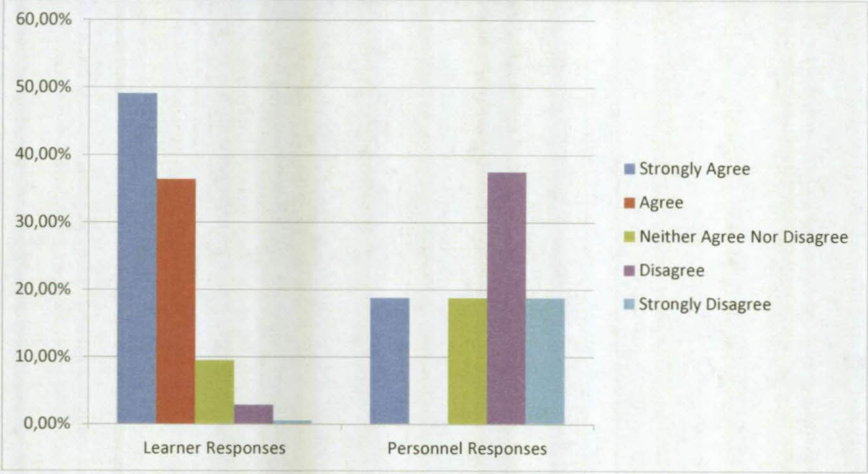
Questionnaires: PA. 4. to PA. 8; LA. 7 to LA. 11.

The interviewees support unsuccessful school leavers education based on workshop practice (Interviewees A, B, E, F, H, I, J, K, N, O, P, Q, R and U). Only Interviewee M doubted the learners' predisposition regarding manual labour, having reservations about learners' willingness to "do manual labour and dirty their hands". He said that when they know in advance about work to be done, they simply stay away from learning opportunities. Compulsory attendance is only one facet of the solution. The others are aptitude, interest and educational strategies. Learners should be enrolled because they want to do the course and have the aptitude for that kind of education. Measures to ensure enrolment, matching learners' aptitudes and interests and effective education, should be implemented.

College respondents suggest welding, basic mechanical work, basic automotive repairs and component fitting as possible mechanical skills divisions for unsuccessful school leavers' education. In the civil field, five possibilities are suggested and in the electrical field, three. All of these have the potential to be entrepreneurial, lower level skills, orientation and bridging programmes offering the option of progressing to higher levels of education: learnerships, apprenticeships and NC(V).

Regarding the academic component – Graph 5.9 – learners want the academic component of the education to be directly related to the practical work, but personnel have a more balanced view.

Graph 5.9: Significance of the academic component in the envisaged education.



Questionnaire: LA. 12; PC. 16.

Educational content and teaching strategies that can accommodate the needs of the learners concerned and ensure reasonable progress should be pursued. According to the personnel respondents and interviewees the knowledge content of the envisaged education should be more comprehensive than what is required for calculated execution of tasks and trade theory (Graph 5.9). Interviewee A summarises the perspective with, "Practical training with the necessary knowledge added." This notion substantiates the suggestion that cognitive development of unsuccessful school leavers is essential for learning and further development, which constitutes language, mathematics and science development beyond the requirements of the projects/practica.

Learners' unacceptably low performance in academic activities provides them no option other than some kind of practical training or education. There ought to be some kind of *situation analysis* included in the orientation stage of unsuccessful school leavers' education, aimed at bringing the learners back to reality. Orientation proceeded by psychometric and aptitude tests could expose more of the learners' aptitudes and interests for proper placement (Interviewee N). A programme based on practical training with supporting knowledge and values can be expanded in various directions to accommodate development of learners to potential.

5.3.7 ENTREPRENEURIAL DEVELOPMENT FOR UNSUCCESSFUL SCHOOL LEAVERS

Owing to the high unemployment rate amongst South African youth, entrepreneurships are options that should be seriously considered. Incorporating entrepreneurship development in the curriculum adds significantly to the opportunities of unsuccessful school leavers (cf. 1.5.2; 2.5.5; 3.4.3.3).

5.3.7.1 Entrepreneurial characteristics

Becoming an entrepreneur requires comprehensive knowledge, skills and aptitude. Some of the important characteristics are personality traits, but with education (knowledge and practice) successful entrepreneurs can be developed.

FET college respondents give a list of 20 attributes which they regard as essential to be successful in entrepreneurships. They encompass attitude, volitional and character attributes, knowledge and skills shown in the list below:

Attitude	**Volition**	**Attributes**
Business minded	Dedication	Determination
Think success	Discipline	Hard Working
Innovative	Risk taker	Focus on own strong points
Creative	Problem Solving	Planner
Energetic	Never consider possibility of failure	Good interpersonal relations
Confident	Motivated	Financial management skills
Responsible	Passionate with what you do	

Entrepreneurships are undoubtedly not for everyone, but with limited alternatives these options should be considered by unsuccessful school leavers. Different possibilities can be considered, especially partnerships, in entrepreneurial endeavours. Entrepreneurship development is seriously considered a facet of the unsuccessful school leavers' curriculum scope.

5.3.7.2 Entrepreneurial prospects

Entrepreneurial prospects are regarded as an option to obviate the current poor employment prospects. College respondents have their reservations about the prospects of unsuccessful school leavers becoming entrepreneurs according to their open-ended responses, but 62,6% of them belief that entrepreneurial attributes can be developed. Interviewees have a more realistic view regarding entrepreneurships as only one of the options for unsuccessful school leavers (Interviewees E, G and O). Equipped with entrepreneurial skills and knowledge, learners have another option if they cannot find employment. Innovation and problem solving should feature strongly in unsuccessful school leavers' education to give them the skills and sensitivity to spot opportunity.

Smith (2011:5) supports entrepreneurships development with her comment, "In this regard it is important that the ***lack of entrepreneurship*** in South Africa be addressed." The economical climate, unfavourable to "job-creation" equivalent to the increase in NEET numbers, predicts escalation of the imbalance in "supply and demand" in the employment situation for school leavers. Carree and Thurik's (2010:588) notion favours entrepreneurships development: "Entrepreneurship generates growth because it serves as a vehicle for innovation and change, and therefore as a conduit for knowledge spill overs." Entrepreneurships seem to be a feasible consideration regarding self-sufficiency and development of a micro-level business class in South Africa's economy in an effort to alleviate the socioeconomic burden of unemployment.

According to the United State of America's Senate Committee on Small Business and Entrepreneurship (2010) such development has the potential of positively influencing the economic climate and job creation. They regard small businesses and entrepreneurships as an "engine" in economy stimulation and job creation. South African research into this aspect can clarify the influences of entrepreneurships and micro businesses on unsuccessful school leavers' socioeconomic situation and business climate. Informal businesses may contribute to the economy rather than threaten existing businesses.

In their own interest and the interests of the country, businesses should support micro entrepreneurial development and micro business development rather than opposing it. The choice the business community should make, is simple: pay the education bill and live with minor competition or pay the social bill and put up with welfare, unemployment, crime protection – and frequent robberies.

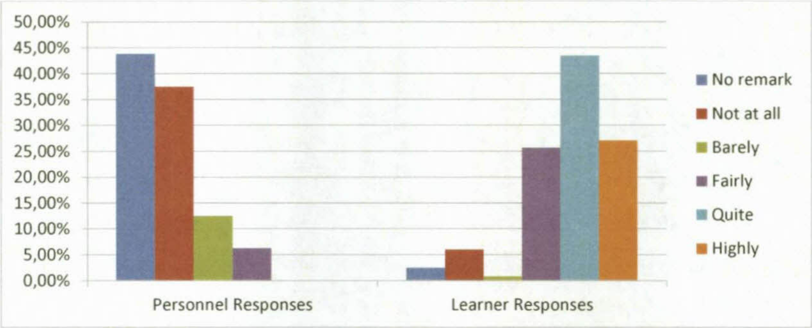
In the mechanical subfield of engineering there are a number of nonthreatening (to businesses) propositions for entrepreneurs. The college respondents compiled a list of 10 "viable" enterprises in the "field" of mechanical engineering into which unsuccessful school leavers can venture after completion of their education. These propositions can simulate business, job creation and contribute to community development.

5.3.7.3 Innovativeness of unsuccessful school leavers

Innovation is a valuable entrepreneurial attribute that can benefit prospective entrepreneurs in critical thinking and problem solving. It is however, only one of many attributes imputed to successful entrepreneurs. Development of critical thinking and problem solving, essential skills for entrepreneurs, are important outcomes in education and are incorporated in unsuccessful school leavers' education.

The innovativeness of unsuccessful school leavers seems, according to the personnel respondents, not one of their strong attributes (Graph 5.10), but with an appropriate educational foundation for further development and the necessary capacity-building endeavour, the situation may be different. Entrepreneurial attributes (knowledge and skills) can, according to the respondents, be developed (Graph 5.10). Considering the limited employment prospects unsuccessful school leavers have, entrepreneurships should not be excluded from their list of opportunities.

Graph 5.10: Innovation inquiry responses by personnel and learners



Questionnaire: PA. 9; LA. 14.

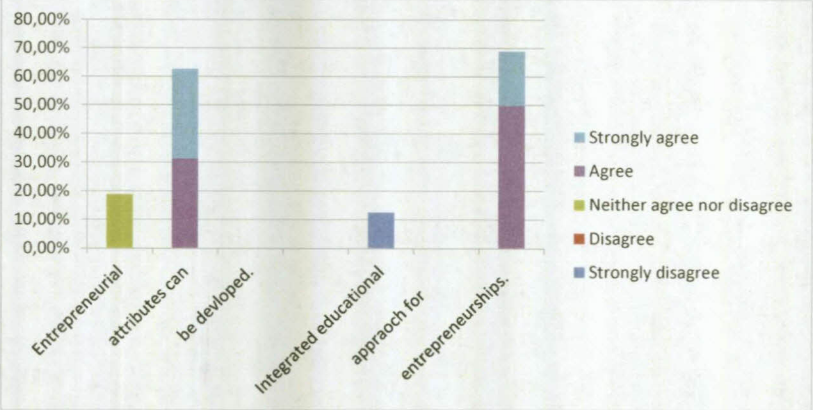
Considering their chances to begin an own business learner respondents are quite optimistic (84,3%), supported by the their wish to have an own business (75,6%) (LD. 1; LD. 2). These responses should be capitalised on to create an entrepreneurial climate in the envisaged education for unsuccessful school leavers.

Personnel respondents are not convinced that unsuccessful school leavers have the necessary attributes entrepreneurships require, but they expressed the opinion that it can be developed (Graph 5.11).

5.3.7.4 Entrepreneurial skills development

Entrepreneurial skills can benefit small entrepreneurship development and multiply the prospects of the unemployed youth of the country. Such small entrepreneurial businesses can develop into a foundation for the establishment of small businesses, which in turn, can contribute to job creation. Having more economically active people implies bigger turnover and stimulation in that underdeveloped sector of the economy – "remains an inadequate focus in educational curricula" (Smith, 2011:6). Expanding the entrepreneurship and small business base of South Africa can become a driving force, in poverty alleviation and economic growth.

Graph 5.11: Entrepreneurial attributes can be acquired – a personnel perspective
Knowledge and practice for entrepreneurships should be integrated



Questionnaire: PD. 1; PD. 2.

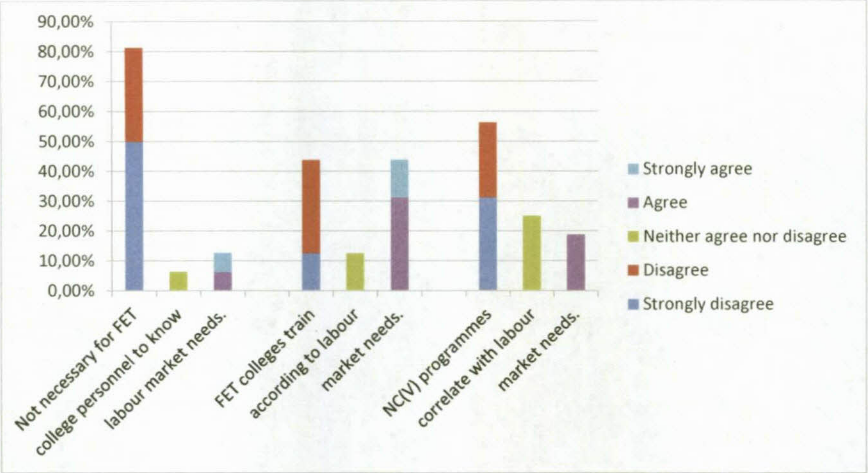
The attributes required to become an entrepreneur point towards comprehensive knowledge and skills development, which should be substantially integrated. The basic knowledge requirements are also listed, but the former statement should be kept in mind. All the knowledge should be fundamental to the skills required. Further development in any of the fields is the prerogative of the learners and should not be limited. Learners should have open pathways to higher levels of education: apprenticeships, learnerships, NC(V), lower-level skills occupations or entrepreneurships. These educational options are discussed in Chapter 2.

Regarding entrepreneurship development, FET colleges (or the institutions designated) should develop a policy of guiding learners into their prospective entrepreneurships and post-education support. Developing learners into entrepreneurships and independence is a process that should commence in the early stages of their education allowing development of the entrepreneurships during that period. Incorporating these features of learner support in the curriculum can encourage entrepreneurship development. When leaving the college learners should have established entrepreneurships.

5.3.8 EMPLOYMENT PROSPECTS OF UNSUCCESSFUL SCHOOL LEAVERS

Personnel respondents are of the opinion that FET college personnel should be aware of labour market needs (Graph 5.12). Their opinion of college responsiveness to labour market demands are inconclusive, but are not encouraging for prospective employees anticipating employment after completion of their qualifications. FET colleges, being institutions of vocational education, are supposed to educate according labour market demands.

Graph 5.12: FET colleges' responsiveness to labour market needs



Questionnaire: PC. 7; PC. 17; PC. 18.

Guide learners in their occupation selection and help them find occupations after completion of their education is regarded a support function of FET colleges. In the envisaged education for unsuccessful school leavers educators' support in decisions learners should make for future development and employment or self-sufficiency will be of paramount importance. Learners should be aware of their prospects and the prognosis of their specific choices. Guiding learners along the route to further education, semiskilled occupations or entrepreneurships can improve learners' chances of survival in the opportunities selected.

5.3.9 INSTITUTIONS FOR UNSUCCESSFUL SCHOOL LEAVERS' EDUCATION

FET colleges are identified by almost all interviewees as the institutions most suitable to offer the envisaged programmes. Proponents of the idea of expanding the college curriculum scope mentioned,

- underutilised facilities and equipment;
- colleges are equipped to do skills development;
- colleges have what is needed; and
- colleges always were there to offer that kind of education

as motivation for the establishment of these programmes (Interviewees B, C, F, G, H, N, O, P, R and T). If colleges are sponsored, they can "take up the challenge" and "these programmes need not be expensive" were other comments made in favour of the idea (Interviewees A, O).

Opponents of the idea motivated their viewpoint with comments such as:

- "colleges are not equipped"
- "human resource situations at colleges do not allow additional programmes"
- "it would be adding more to an already overloaded FET sector"
- "colleges should not embark on other lower level skills development programmes"

This is contradictory, but more of an indication that the sector is underdeveloped, rather than incapable. Cloete et al (2009:79) regard, "... the relatively underdeveloped state of our FET college system at present" detrimental to "establishing fully fledged community colleges." Research, addressing the shortcomings and solutions to these, will be more than welcome to the personnel at these colleges. Without the intention to quantify the motivations given, it can be mentioned that 87,5% of the interviewees support expansion of the curriculum scope at FET colleges. Smith (2011:14) mentions the implication of the current educational policy: "Given that the FET colleges require a NQF 1 qualification for entry, the 50 FET colleges and their approximately 278 delivery sites are thus meant to serve mainly those that dropped out after Grade 9 and those who failed matric."

5.3.10 POSITION OF UNSUCCESSFUL SCHOOL LEAVERS' EDUCATION IN SA SYSTEM

Unsuccessful school leavers' education, in this study, is a proposal for second chance education for those who could (and can) not respond appropriately to mainstream school and FET college education. They have specific educational needs that cannot be addressed in the current education system and therefore drop out just to be confronted with the harsh reality of high unemployment and no second chance in education.

The envisaged education will be orientation, bridging, lower level skills and entrepreneurship development. It can only be incorporated at a level below NQF 2 in the education system of South Africa. In SAQA terms it will be NQF 1, but not equivalent to GET, ABET, SNE or RemSpecEd because these programmes are developed for learners with specific needs different from unsuccessful school leavers' educational needs. Unsuccessful school leavers' education will offers a second chance in education that can build educational foundations for (re-)entry into vocational education, lower level skills or entrepreneurial preparation.

5.3.11 ENROLMENT POLICY OF FET COLLEGES

Enrolment policy is an inconclusive consideration in FET college procedures. Interviewees mentioned various criteria at different colleges, from previous academic level to psychometric and aptitude tests (Interviewees C, D, F, G, P, R and U). The general notion that surfaced is that colleges prefer Grade 12 learners because they achieve better NC(V) 2 results. This is problematic because it is expected of learners to achieve NQF 4 level (Grade 12) at school and repeat NQF 2 to 4 at an FET college – time and cost duplication. Learners are unwilling to repeat NQF levels already achieved at schools regardless the standard of education (Interviewees G, I and K).

Mentioning no references to policy, interviewees referred to colleges basically enrolling learners according to age and Grade 9 as the only criteria. Everybody is welcome in the pursuit of numbers (Interviewee B). Compulsory enrolment as a departmental/ministerial policy, as reported by some colleges, is virtually the same situation as having no policy (Interviewees E, H, I, J, K, L, M, N and T). All the applicants who exceed the age restriction and qualification limit are enrolled regardless of ability, aptitude and educational foundation.

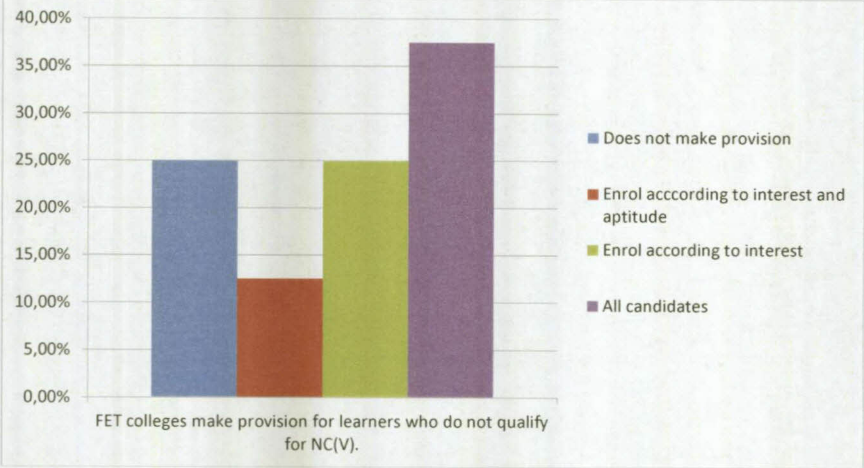
College responses confirm diverse enrolment policies for learners who do not "qualify" for NC(V). Twenty-five percent of the respondents mentioned no provision for candidates who do not meet their criteria, 12,5% allow candidates on interest and aptitude, 25% on interest and 37,5% make provision for all candidates. It is assumed that some colleges enrol unsuccessful school leavers, in addition to NC(V), in skills development courses because these courses are offered at these colleges and some learners/parents can afford the course fees. Skills development courses must be financially self-sustaining (Interviewee D).

Compulsory enrolment, "enforced" by the authorities, mentioned by some interviewees and expecting educational success, is a message to colleges that they have to rectify the consequences of low-quality education of schools. FET colleges are thereby commissioned to cater for unsuccessful school leavers (Smith, 2011:14). Currently, FET colleges do not have the means or the mode to honour such an assignment. Accommodating these learners will require orientation/introductory, lower-level skills development, bridging and entrepreneurial skills programmes. Offering remedial and engineering education simultaneously or with the same (NC(V)) programmes, is not a feasible endeavour. Resorting to NATED programmes with their limited scope, no languages and lack of remedial attributes is even less suitable.

Interviewee S regards remedial education as the responsibility of the institutions encountering the educational (learning) problems causing the dropout. "I do not agree with schools that drop these students. The mandate of FET Colleges is to enhance progression in terms of teaching and learning – to prepare learners for specific occupations. These learners should be regarded as students like any other students in the country who need space to progress in terms of academic activities. It is not acceptable to regard these students as dropouts and refer/channel them to FET Colleges because that is a sector that does hands-on or practical activities and these students can do practical more than theory. All providers of education must be willing and must be in a position to accept these students."

Seventy five percent of FET college respondents report that they make provision for learners who do not qualify for NC(V) enrolment in some way (Graph 5.12). The programmes offered to these learners are not orientation or bridging courses as mentioned in 2.5.1. They are therefore enrolled in short skills development courses, which are commendable, but the educational needs of the learners are not addressed.

Graph 5.13: Enrolment policies of FET colleges – personnel respondents' perceptions



Questionnaire: PB. 1.

5.3.12 RESEARCH RESPONDENTS' PERSPECTIVE ON CURRENT ENGINEERING CURRICULA AT FET COLLEGES

The educational prospects of unsuccessful school leavers are limited by their poor performances in preceding education. Already proven ineffective, they cannot return to mainstream school education. Their efforts in engineering programmes at FET colleges reveal even poorer results leaving them without viable educational options. Education to re-establish their education careers should build sound educational foundations and provide opportunities to develop up to re-entry into further education, lower level skills or entrepreneurships. Further education prospects comprise NC(V), learnerships and apprenticeships.

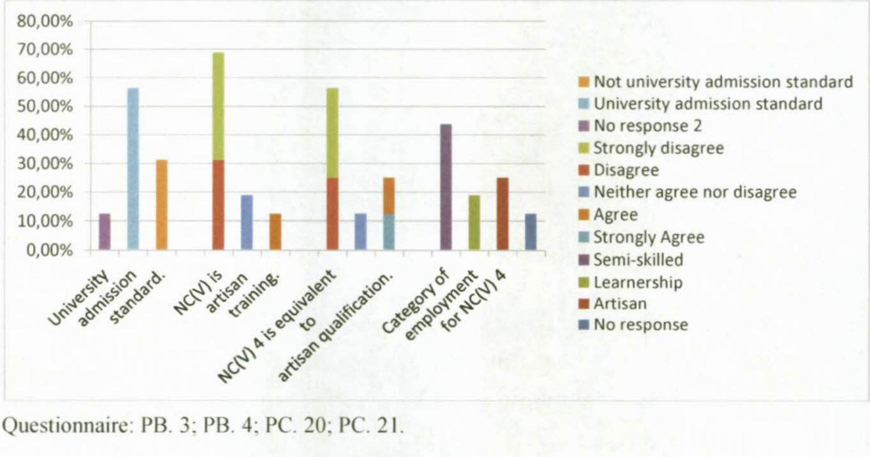
5.3.12.1 Qualification value of NC(V) engineering programmes

Qualification value of NC(V) is currently an issue because it was declined by the SETA's and universities require higher than normal marks for admission. Interviewees mentioned marks for fundamentals, as university admission criterion, to be a minimum of 50% to 59%, with 70% to 79% required in vocational subjects (Interviewee H; cf. 2.3.2.3; 2.4.1). The majority of college respondents, supported by Interviewee S, are confident that NC(V) 4 meets the minimum requirements of relevant university courses (Graph 5.13).

The majority of college respondents disagree that NC(V) is equivalent to an artisan-training course. They regard the practical (workshop) component of the qualification as insufficient. In a cross reference question 60% refute artisan status for successful NC(V) 4 candidates and 26,6% regard it as appropriate (Graph 5.13). Interviewees agree that the practical component of NC(V) is insufficient to effectively train candidates up to artisan level (Interviewees H, L, M and N). This information and the declination by SETA's confirm that the practical training of NC(V) is insufficient to be equivalent to artisan training. Smith (2011:30) reports that, "employers are sceptical of the value of the NC(V) qualification."

Unsuccessful school leavers cannot fully benefit from the too small practical component because their education should be based on the practical component complemented by relevant knowledge. All the theory and knowledge must be directly related and applicable to the practical work: this notion is supported by the interviewees, A, I, K, R, and S. The situation of unsuccessful school leavers is too different from the purpose of NC(V) to be considered adequate education satisfying their educational needs. Entrepreneurship does not feature prominently in NC(V) programmes. Management programmes have entrepreneurship as a subject only in NC(V) 2. NC(V) cannot be regarded as sufficient to cover the scope from university admission standard to entrepreneurships (Department of Higher Education, 2010).

Graph 5.14: Personnel respondents' perception of NC(V)



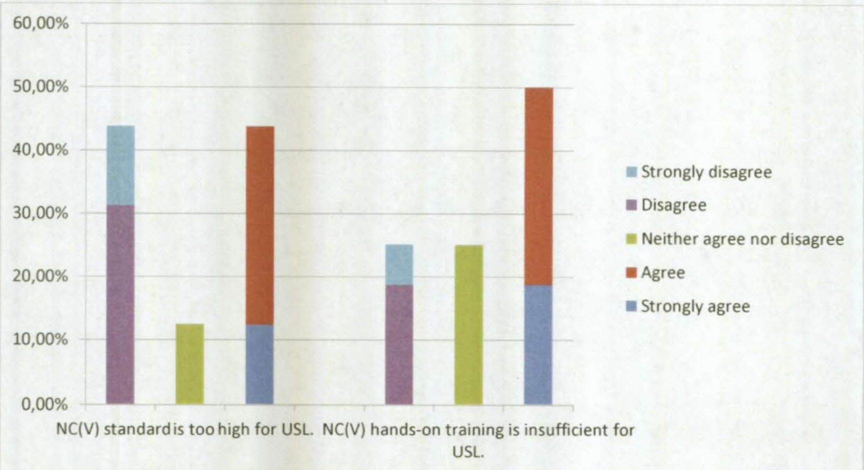
Questionnaire: PB. 3; PB. 4; PC. 20; PC. 21.

It cannot be possible to meet the requirements of higher education with NC(V) programmes and simultaneously accommodate unsuccessful school leavers effectively in the same programmes. The needs of unsuccessful school leavers and prospective university candidates differ substantially. FET colleges have a daunting task. NC(V) is supposed to be a suitable programme for a whole spectrum of candidates from higher education to school dropouts – excellence development and remedial education simultaneously. They have to develop university, artisan, entrepreneurs and lower level skills candidates with the same programmes, which is not possible.

5.3.12.2 Appropriateness of NC(V) as unsuccessful school leavers' education

The standard of NC(V) programmes is too high for unsuccessful school leavers (Graph 5.14). Although 43,8% of the college respondents believe that the standard is not too high, examination results and interview responses tip the scales in favour of the too high notion (Interviewees B, P, R, T and U). Forty-three percent of the respondents belief it is too high, which created a checkmate situation if only the personnel respondents are considered. Some interviewees have their doubts about the focus of NC(V) programmes, which is regarded as "academically" orientated (Interviewees B, G, L and M).

Graph 5.15: Appropriateness of NC(V) as unsuccessful school leavers' education



Questionnaire: PC. 11; PC. 22.

The existence of suitable education for unsuccessful school leavers is denied by 53,3% of the college respondents. A majority (68,8%) also disagree that skills development programmes meet the expectations of unsuccessful school-leavers' education. Unsuccessful school leavers' education should be more comprehensive than skills development programmes, which are fragmented chunks of learnerships (cf. 2.5.1).

5.3.13 NONFORMAL EDUCATION AVAILABLE TO UNSUCCESSFUL SCHOOL LEAVERS

Nonformal education has the potential of providing opportunities of skills acquisition to unsuccessful school leavers, but it should address the educational needs of the learners beyond skills development. Limiting the opportunities to skills development will leave the learners (again) with limited prospects and excluding further education on NQF 2 level and beyond. Without education foundation construction, further education will remain a daunting prospect to them.

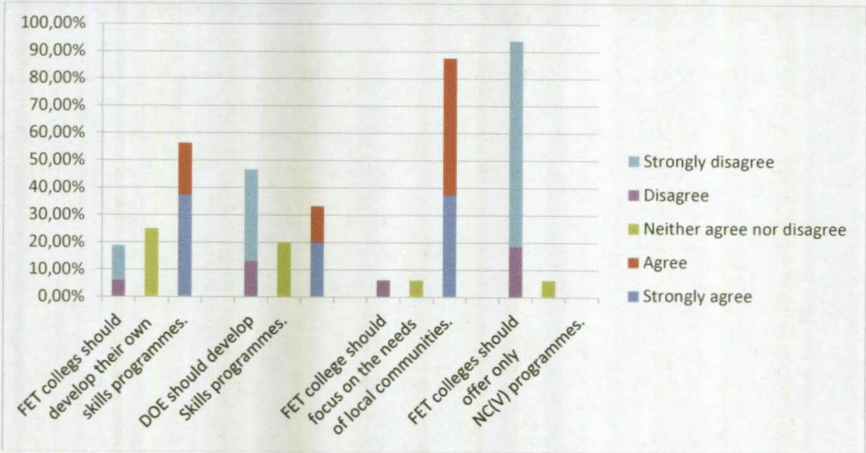
5.3.13.1 Nonformal education at FET colleges (prospects for unsuccessful school leavers)

There is an urgent need for additional curricula in engineering studies at FET colleges. 87,5% of college respondents endorse the idea of nonformal programmes to accommodate unsuccessful school leavers and other learners who do not qualify, in real terms, for NC(V) programmes. In cross-referencing 93,8% disagree that FET colleges should offer only NC(V) programmes. The importance of addressing the needs of local businesses and community is admitted by 87,5% of the college respondents, a notion included in the idea of unsuccessful school leavers education.

The idea of nonformal curricula designed and developed by FET colleges according to local demand is endorsed by 56,3% of the respondents (Graph 5.15). Only 33,3% of the college respondents regard development of nonformal (skills) curricula to be the responsibility of the Department of Education (DOE) while 46,7% disagree (Graph 5.16). This corresponds with the data in the graph where 56,3% are in favour of development of skills programmes by the FET colleges.

They also believe that successful nonformal learners (unsuccessful school leavers) can get employment as semiskilled employees. Locally developed programmes can be tailored to the needs of local business and communities. They can furthermore be adapted when necessary to eliminate shortcomings and accommodate other needs without the red tape that causes improvements in formal courses to take several years. (Updating of some crucial NATED syllabi has not been done since 1980 (Department of Education, 2007b:9)).

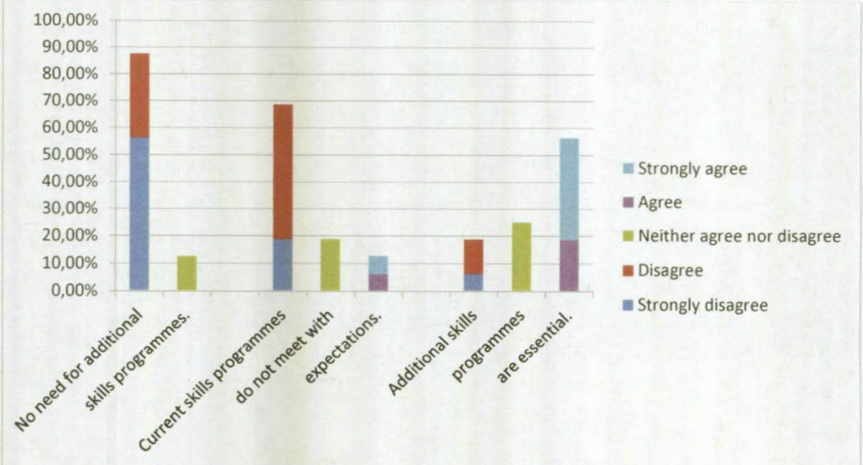
Graph 5.16: Respondents' view of FET college nonformal programmes



Questionnaire: PC. 2; PC. 3; PC. 4; PC 5.

Further justification for nonformal education at FET colleges is given by the interviewees. They suggest lower level skills development to qualify artisan assistants, an orientation/bridging programme and self-sufficiency (entrepreneurial) programmes for learners lacking the foundation for NC(V). They are of the opinion that broadening the scope of FET college programmes will enable colleges to increase learner numbers, improve utilisation of facilities and equipment and excel beyond the current confinements (Interviewees F, G, H, I, J, L, N and S).

Graph 5.17: Additional skills programmes for FET colleges



Questionnaire: PC. 8; PC. 9; PC. 12.

According to 80% of personnel respondents, FET colleges primarily offer programmes prescribed by the Department of Education. From Graph 5.17 it is evident that they are of the opinion that additional programmes should be included in the programmes scope.

From Graph 5.17 it is evident that personnel respondents are of the opinion that current nonformal programmes (skills programmes) do not meet the requirements of learners, confirming the conclusion that they do not offer substantial education (cf. 2.5.1). Additional programmes at FET colleges are essential to provide appropriate education to a diverse population with a variety of educational needs. Concerns about unsuccessful school leavers and their plight only highlight the dilemma of many learners lacking foundation for further or higher education, the funds to acquire skills and their poor employment prospects.

5.3.13.2 Educational approach in nonformal programmes

A suitable educational approach for nonformal programmes is suggested by college respondents and interviewees. The bases for these programmes (curricula) must be practical activities supported and complemented by relevant knowledge. All the college respondents agree that such programmes should be integrated curricula. In cross-referencing, 81,3% support integrated curricula, which is substantial support for the approach. Although integration of theory and practice is included in the NC(V) curricula, the theories of curriculum integration do not get much attention. The interviewees mentioned completion of the academic components before venturing into the "practical" as fairly general educational practice. The notion of theory and practice integration constitutes simultaneous offering – simultaneous acquisition of declarative and procedural knowledge.

Interviewees take the notion a little further into integrated programmes where the necessary knowledge is "brought in via the skills", pointing towards transdisciplinary integration (Interviewees B, C, D, E, H, J, M, N, Q and S). Practical (workshop) skills are emphasised, but they stress the importance of knowledge assisting the execution of tasks. Bringing in problem solving techniques will inevitably add to the reservoir of knowledge for learners building a foundation for future learning.

The lecture as teaching strategy is still a favourite among educators because it has a well-developed structure and accompanying techniques (Interviewees D, G, Q, S, U). It is a timesaving, large group method, but should be carefully developed to prevent educator-centred presentations, passive learners and rote learning. In the educational model proposed by the interviewees, lectures will only be an occasional occurrence.

Classical education is not associated with integrated curricula, but as a technique to establish ready knowledge supported by memorising techniques, it can be useful. Project/practical-based learning opportunities should preferably not be constructed upon a classical education base because there are more effective ways of teaching and learning, which involve active participation by learners.

The current curricula, attempted by and available to unsuccessful school leavers after dropping out of school are therefore included in the search for an appropriate educational approach. These programmes failed to address the educational needs of unsuccessful school leavers (cf. 2.5.1). Evaluating these programmes can therefore contribute to a better understanding of the educational situation of unsuccessful school leavers and the formulation of guidelines for the envisaged curriculum and concomitant education.

5.3.13.3 Unsuccessful school leavers' education: suggestions by personnel respondents

The educational approach suggested is practical (hands-on) education with transdisciplinary integration – no separate subjects and fully integrated knowledge, theory and practice. Interviewees suggested orientation, bridging and skills development, practical-based (hands-on) integrated education. The curriculum should cover the scope: orientation/introduction, lower level skills, entrepreneurships and bridging to higher levels of education, e.g. learnerships, apprenticeships and NC(V) (Interviewees A, B, C, D, E, H, J, K, M, N, O, Q, R, S and U). Interviewee H suggested "two-component" unsuccessful school leavers' education: preparing learners for occupations and further education.

Starting with orientation, learners can progress through the programme into skills development, artisan assistants, entrepreneurships or bridging course depending on aptitude and knowledge foundation. Fundamentally, this programme of practicum-based education will be a version of project-based education with the necessary adaptations to encompass the unsuccessful school leavers' situation. The name practicum-based education is preferred because it signifies learner activity. Project-based education focuses on the project as source or initiator of learning content and ***practicum-based education focuses on the procedures (practica) learners have to accomplish in competence (integrated declarative and procedural knowledge) development***.

Interviewee L suggested breaking up the conventional trades into small fractions of specialisation. This would increase employment prospects and make the consequent education easier for the learners. It can be incorporated in the plan of lower level skills development. A shortage of lower level skills exists in South Africa. Development of unsuccessful school leavers can provide a work force for trade and industry, from lower level skills to skilled *support staff* for trade and industry (Strumpf et al, 2009:5).

5.3.14 FET COLLEGE PERSONNEL

An investigation into the proficiency of FET college personnel as partners in the education of unsuccessful school leavers is not in the scope of this study and they will be regarded as competent, concerned and dedicated educators with vision and commitment until proven otherwise. The comments of interviewees will also not be included in this analysis because it is not regarded as sufficient evidence for inferences in the matter, but Cloete et al (2009:16) regards, "Generally low levels of academic staff capacity and quality in FET colleges" a "disabling factor in establishing a strengthened FET college system."

However, it remains the responsibility of FET college managements to monitor education at the colleges and ***provide all the support*** they can muster to the educators because they have a daunting, but indispensable task. They have to educate learners, who could not succeed in school education and consider FET engineering education as a last resort, with programmes equivalent and in some instances beyond the standard of school programmes. Unsuccessful school leavers could not succeed in school education. How can they succeed in education (NC(V)) beyond their educational capacity? Their educational foundation lacks the basic requirement of language, mathematics and science.

5.3.14.1 Interviewees' perspectives on teaching styles

From the interview data it can be inferred that that the unsuccessful school leavers' educator should be a qualified artisan with industrial/workplace experience and know-how to facilitate effective learning. The interviewees describe the educator as an "expert," "formal authority," "role model," "facilitator" and "delegator." Demonstration, *involving the learners in hands-on participation*, is the mode of presentation considering the practicum-based educational approach. Learner participation starts at commencement of the demonstration. They regard combining teaching approaches according to practicum project strategies and learner activities as recommendable.

Some of the interviewees regard the traditional lecture as essential backup for the practical hands-on demonstration, enhancing explanations, correctional activities and consolidating the learning content. Sorting out specifics from time to time in group context is, according to them, inevitable. The media at the educator's disposal and the well-developed structure of lectures provide means, mode and manner unequalled in practica. They are adamant that a more "pragmatic" approach, adapting to circumstances, is preferable to a standardised lecturing method.

5.3.15 SUMMARY OF UNSUCCESSFUL SCHOOL LEAVERS' BASIC EDUCATIONAL NEEDS

The learners' academic level and abilities are not conducive to development and progress in the current educational programmes at their disposal. There are a number of shortcomings confirmed by the research:

- Inability to learn in linguistic-logic educational environment
- Lack of aptitude and propensity for linguistic-logic education
- Poor abilities in comprehension and insight in academic learning content
- Poor mathematics proficiency
- Poor science proficiency
- Poor language proficiency

The research also reveals other factors contributing to the poor academic performances. Poor career guidance and lack of commitment are some of the contributing factors that have been identified. Consequences of preceding school education, vocational predisposition and predilection of the learners may further contribute to the poor results recorded.

The method (or approach) identified by the research is hands-on practical training, but the factors contributing to poor performance should also be addressed. Unsuccessful school leavers are an "intellectual and aptitudinal diversity" complicating teaching and their education in general. An approach to education that can accommodate differences in ability, aptitude and their learning barriers should be pursued. Such an approach should be transdisciplinary practicum-based education adapted to their specific situation. Knoll (1997:9, 10) reports a move away from the *theory first practice later* approach towards a *central position for practice* in Europe after World War II. With the project as the centre of attention, learning could be initiated with a practicum. All the knowledge was related to the project, but learning should be allowed beyond direct relationships into higher levels of cognitive development. That could have developed into education beyond the "often controversial" project-based education of Kilpatrick (Knoll, 1997:1).

5.4 CURRICULUM BENCHMARKING

Development of the curriculum according to the design cycle is a recurring process because every facet influences and is influenced by the other facets. One facet is not completed before venturing into the other. As contributing parts to the whole, each one must be compared and aligned with the other, the objectives, outcomes and aims to ensure right and healthy relationships and achievement of the standards.

Curriculum benchmarking is a continuous process integrated in the design, implementation and operational phases of the curriculum. Benchmarking criteria guide the design process and provide norms for functional judgement in the operational phase. A curriculum needs to be assessed continuously and adaptations made to eliminate shortcomings.

Evaluation involves procedural efficiency (quality curriculum implementation) and content validity (relevance and factual correctness). Continuous evaluation of the curriculum during the operational phase (implementation) is also necessary to make essential adjustments for ultimate performance of the learners. For the sake of feasibility and credibility, a panel evaluation was done by three training experts in industry to benchmark the curriculum. Unfortunately four other experts did not respond in time. Group judgement does not only provide perspective to the developer, but can predict the feasibility of the curriculum.

5.4.1 DELPHI METHOD OF EVALUATION

External curriculum appraisal was arranged with senior educators/training facilitators in the motor and mechanical engineering industry. Seven educators/training experts from industry accepted the invitation to participate in the panel benchmarking of the curriculum, but only three returned the assessment documentation. The other did not comment on the curriculum or unit standards provided. An experienced training facilitator from the Metal and Engineering Industries gave full cooperation and valuable feedback. A Training Advisor from the Retail Motor Industry provided the balance in the focus of the curriculum with inputs from the motor repairs perspective. From a training provider's perspective a service provider to the SETA's and former training manager in the retail motor trade enhances perspective on the feasibility and credibility of the curriculum. His academic background – a PhD degree – qualifies him as a valued assessor of curricula. They all cooperate in a professional manner and provide essential inputs.

The process was organised according to the Delphi method. Copies of the completed curriculum, together with assessment criteria, were sent to the panel for anonymous comments, opinions and judgments. When the evaluations were returned, the scores were compared, the comments assessed and changes considered. In the following round the evaluations of other participants and new evaluation forms were sent to each member of the panel for re-evaluation. The panel expressed their opinions on other comments and reassessed the curriculum, based on other members' judgements. Normally the process is repeated until consensus is reached (Edgren, 2006:410). The outcome of the process is incorporated in the final curriculum.

The primary concerns with curriculum design are feasibility and credibility, which involve procedural efficiency and content validity. Carl (2010:140) suggests "two facets" for curriculum evaluation "effectiveness/functionality" and the "acceptability" signifying the selected norms. A rating scale with five levels is used for the curriculum benchmarking enabling assessment of value and progression in the external evaluation.

The scale ranges from 5 to 1 with 5 representing the highest positive value and 1 the lowest.

Feasibility scale: To what extent does the curriculum meet the programme criteria listed?

5	Excellently
4	Largely
3	Reasonably
2	Fairly
1	Barely

Please tick the relevant value.

1	Curriculum meets the requirements of introductory technical education	5	4	3	2	1
2	Curriculum meets the requirements of lower level skills occupations*	5	4	3	2	1
3	Curriculum meets the requirements of a bridging course into learnerships	5	4	3	2	1
4	Curriculum meets the requirements of a bridging course into apprenticeships	5	4	3	2	1
5	Curriculum meets the requirements of a bridging course into NC(V)	5	4	3	2	1
6	Curriculum meets the requirements of competency for micro-entrepreneurships	5	4	3	2	1
7	The curriculum is practicable – based on a sound executable concept	5	4	3	2	1
8	The curriculum fills a gap between school education and technical	5	4	3	2	1
9	The curriculum is educator friendly – clear, unambiguous, informative	5	4	3	2	1
10	Units are linked into a significant whole	5	4	3	2	1

*e.g. artisans' assistants, component fitters, unit strippers

Credibility scale: To what extent does the curriculum meet the learning criteria?

5	Extremely credible
4	Highly credible
3	Meets the minimum requirements
2	Fairly meets the minimum requirements
1	Does not meet the minimum requirements

Please tick the relevant value.

1	The curriculum covers the curriculum outcomes	5	4	3	2	1
2	The curriculum covers the critical cross-field outcomes	5	4	3	2	1
3	The curriculum covers the personal developmental outcomes	5	4	3	2	1
4	The context of the curriculum offers real life practices	5	4	3	2	1
5	The curriculum makes provision for language development	5	4	3	2	1
6	The curriculum makes provision for mathematical development	5	4	3	2	1
7	The curriculum makes provision for science development	5	4	3	2	1
8	The curriculum complies with transdisciplinary curriculum integration	5	4	3	2	1
9	The curriculum sufficiently links prior knowledge to new information	5	4	3	2	1

10	The curriculum makes provision for integrated knowledge and skills	5	4	3	2	1
11	The curriculum offers practical-based education extending into further knowledge	5	4	3	2	1
12	The curriculum offers multi-sensory learning opportunities	5	4	3	2	1
13	The curriculum makes provision for group work	5	4	3	2	1
14	The curriculum requires learner involvement and practical hands-on	5	4	3	2	1
15	The curriculum incorporates comprehensive summative continuous assessment	5	4	3	2	1
16	The curriculum incorporates formative, continuous assessment and	5	4	3	2	1
17	Assessment criteria are adequately specified	5	4	3	2	1
18	The curriculum can facilitate effective learning: knowledge, skills and values	5	4	3	2	1
19	The curriculum is focused	5	4	3	2	1
20	The curriculum makes provision for summative and formative assessment	5	4	3	2	1

After consensus was reached, adaptations were made and recommendations added (Appendix L). The process was conducted in a professional manner and valuable responses were received.

5.4.2 DEVELOPMENTAL EVALUATION

During curriculum design and assembly the results are continuously benchmarked against the criteria to ensure achievement of the desired product conducive to the envisaged education. Judging the design process against the guidelines derived from the research, keep the process aligned with the aim and objectives of the study.

The educational situation of unsuccessful school leavers is a result of poor academic performance. Their capacity to learn needs to be addressed constituting the fundamentals language, mathematics and science, but getting them constructively involved in education, is the challenge facing the institutions and personnel involved. Linking these fundamentals to practica provides the relationships and value, making them more significant to the learners – the reasons for accomplishing proficiency.

Hands-on activities was considered appropriate to get the learners involved and provide a basis for further perceptual-motor and cognitive development. Utilising mechanical projects in practica with a transdisciplinary educational approach, based on a fundamental theory of constructivist learning, constitute the learning opportunities of unsuccessful school leavers' education. Development of the ability to learn effectively, acquisition of knowledge, skills and values (declarative and procedural knowledge construction) are incorporated in the curriculum (Appendix J). The outcomes, included in the units, provide the evidence of their significance in the curriculum.

The desired competences for unsuccessful school leavers are incorporated in the three types of outcome formulated and analysed: national, curriculum and unit standard. Outcomes are selectively included in the unit standards to be accomplished in the practica with the development of integrated declarative and procedural knowledge. Provision was made for language, mathematics, science and mechanics in every unit emphasising knowledge foundation (prior relevant knowledge), relationships, essential knowledge and potential further development. Distinguishing knowledge, skills and values is done to facilitate alignment with the competences described in the outcomes.

The curriculum differentiates into four ultimate aims: orientation, lower level skills occupations, bridging into learnerships and apprenticeships, (re-)entry into NC(V) 2 and micro-entrepreneurships on a level below NC(V) programmes. These different levels are accomplished in the design of the units with differentiated perceptual-motor and cognitive development.

Differentiated perceptual-motor development is possible by dividing the procedures into basic, calculated execution, diagnostic, problem solving and critical thinking. The procedures progressively require higher levels of cognitive involvement signifying the levels of the adapted version of Bloom's taxonomy of learning (cf. 4.3.1). Owing to the increasing complexity declarative knowledge becomes more important without diminishing the importance of procedural knowledge construction. Improved comprehension can improve the quality of the execution of the procedures through a better understanding of the physics, mechanics and consequences involved. Achieving these features was only possible with practicum-based transdisciplinary education as demonstrated in the unit standards.

Continuous benchmarking of the curriculum against the listed criteria keeps the process focussed on the aim of the study: a transdisciplinary mechanical skills curriculum for unsuccessful school leavers.

5.4.3 EXTERNAL BENCHMARKING

The curriculum has been benchmarked against a set of criteria by three training experts in industry. Lower scores were attended to and improvements applied to the curriculum. The positive outcome of the "panel" evaluation is recorded (Appendix L). Unfortunately the final stages, dissemination and operational evaluation, could not be performed. It is, however, the intention to incorporate improvements recommended in a process of piloting or implementing the curriculum if these possibilities are feasible and/or available.

Curriculum benchmarking is an essential integrated facet of curriculum design and development. Considering the dissemination and operational phases, the process is not completed and will continue, depending the outcome of and reflections on this study.

5.4.4 BENCHMARKING RESULTS

The aim of the envisaged education, and therefore the curriculum, is to provide alternative education to NC(V) (and NATED) to equip unsuccessful school leavers with skills, knowledge and values, together with an appetite for opportunity. Furthermore, such a curriculum must accommodate orientation towards technical education, bridging into further education for learners lacking knowledge and skills, lower-level skills preparation and the possibility of establishing entrepreneurships. Learners must be granted a more appropriate programme that can address their specific educational needs. What they can do, is the focus of their preparation supported by knowledge and values – with knowledge beyond that of simply trade theory. Calculated execution of tasks utilising skills, knowledge and values, is key to the success of this kind of education.

The Delphi panel regarded the curriculum as feasible and credible (Appendix L). High positive judgements (4 and 5) were regarded as sufficient correlation to come to the conclusion that the curriculum is feasible and will fulfil the intended function.

5.5 CONCLUSION

The research concluded in a transdisciplinary practicum-based mechanical skills curriculum aiming at educational foundation construction and capacity building for unsuccessful school leavers (Appendix J). A literature study, covering vocational education, South Africa's educational situation, educational approaches, fundamental learning theories, accommodation of learner differences and curriculum design form the foundation and context of the study. Supplementing the literature information, a mixed method empirical research provides the detail and perspective on the educational situation of the learners, named unsuccessful school leavers in this study.

Poor examination results of learners in engineering studies at FET colleges evoked curiosity in their educational situation. This leads to the discovery of poor throughput in FET school education resulting in learners resorting to and/or referred to FET college education because they could not respond adequately to the linguistic-logic predilection of mainstream school education. Unfortunately, FET college engineering education (NC(V) and NATED) is not designed to facilitate education matching the educational profile of these learners. These programmes are not "learn to work with your hands" education per se. Nonformal education, as potential recourse, owing to its limited scope, is also not a viable option to them requiring educational foundation construction added to skills development. The conclusion, therefore, is a different kind of education – transdisciplinary practicum-based education – designed to accommodate the educational needs of unsuccessful school leavers.

The purpose of Chapter 6 is to conclude the research, consolidate perspective on the education intended with the curriculum and to propose it as a feasible, credible option for "second chance education" for unsuccessful school leavers. Additional perceptions on South African education, intended to provide perspective, are mentioned. A number of aspects, worth investigating and possibly enriching to this study, were revealed by the research. These investigations may contribute to South African education and make schooling a pleasant enriching experience to more learners.

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CHAPTER 6

TRANSDISCIPLINARY PRACTICUM-BASED MECHANICAL SKILLS EDUCATION FOR UNSUCCESSFUL SCHOOL LEAVERS

6.1 INTRODUCTION

Education was identified as viable practicable option to address the situation of unsuccessful school leavers and thereby affording them opportunities to escape their precarious socioeconomic circumstances (cf. 1.2.1). Public education in South Africa, however, does not provide education to vouch for such an obligation. It was therefore concluded that a specific type of education should be designed to circumnavigate their poor educational predilection and afford them opportunities to educational foundation construction and capacity building.

A literature study and empirical research provide the declarative and procedural knowledge for endeavouring in curriculum design (Appendices J and K). Proposing this curriculum as feasible and credible option for a specific group of unsuccessful school leavers and motivation for the development of equivalent curricula to cover the spectrum of learners' interests and aptitudes, is the climax of the study. The research conclusion summarises the curriculation effort and position the proposed curriculum in the education system of South Africa.

6.2 RESEARCH CONCLUSION

A précis of the research results is given in this section. Each aspect is considered an integral part of the relevant sections of the study and therefore discussed under these divisions. This summary only concludes the research design and methodology.

Examining, interpreting, comparing and cross-referencing the processed data provide the elements for contemplation and eventually, conclusions could be drawn. Inferences involve "passing judgement" based on the evidence obtained from the processed data and reaching of "conclusions" (Neuman, 2000:418). Data processing, analysis and interpretation (should have) "released" the ideas contained in the gathered information. From the ideas, theories could be constructed and the theories and conclusions could facilitate construction of the rudiments required for a solution to the educational problem encountered by unsuccessful school leavers.

Magnitude and frequencies with a hunch of perceptions, possibilities, prospects and significance are the attributes of the information acquired from the questionnaire responses and opinions, perspectives, interpretations and experiences form the interviews. The primary objectives were to establish a situation analysis and probability construction involving unsuccessful school leavers, their education and prospects. Magnitude and frequencies of information in the questionnaire responses were processed and calculated, utilising a computer programme. Frequencies were selected according to their contribution in enhancing the perspective on the educational situation of unsuccessful school leavers to elucidate arguments in the discussions. However, some of these quantitative data was "buried" in the text rather than representing them in graphs/tables (Davies, 2007:121). The interviews confirm questionnaire responses and provide additional information and perspective on the educational situation of unsuccessful school leavers.

6.2.1 RESEARCH QUESTIONS

The research questions distinguish aspects of the process to be followed in an attempt to find a possible solution to the meagre educational situation of the unsuccessful school leavers. Expanding on the initial identification of the problem into practicable notions, subsidiary questions guide the investigation towards attainment of the objectives, aim and probably the goal as a distant vision.

6.2.1.1 Subsidiary questions

The following subsidiary questions initiated the investigation into the educational situation of the South African unsuccessful school leavers:

- What is the international and South African situation with respect to vocational education for unsuccessful school leavers?

The international and South African situations of unsuccessful school leavers reveal preference for vocational education as an educational strategy to get learners involved in education in attempts to improve their socioeconomic situations. In South African context, vocational education was utilised for upliftment of neglected impoverished en often, delinquent young people. It is therefore reasonable to reach out to unsuccessful school leavers with an educational option that provide opportunities of educational foundation construction and capacity building on par with the European countries.

- Which curriculum development and design theories can form a basis of a curriculum for unsuccessful school leavers?

An empirical research, supported by the literature study, provides the information required for the establishment of the theoretical backing for the curriculum design aimed at a transdisciplinary practicum-based vocational curriculum. Founded on the Nicholls and Nicholls curriculum design cycle, a seven-stage cycle was selected to incorporate the necessary features for accomplishment of the aim.

- Which learning theories, principles and approaches can form a basis for a vocational curriculum for unsuccessful school leavers?

A fundamental learning theory, based on constructivism and further psychological developments in cognitive learning processes, was selected because it supports cognitive and perceptual-motor development, also covering intellectual skills. This theory provides the principles, premises and fundamental framework for learning opportunity design complementary to the educational approach preference of the stakeholders.

- What are stakeholders' (senior personnel) and unsuccessful school leavers' perspectives on an appropriate educational approach to be followed in an envisaged vocational curriculum for unsuccessful school leavers?

The preferred educational approach of lecturers and learners is hand-on activities supported by relevant knowledge. The curriculum design attempts to circumnavigate the negative attitude against learning with practicum-based opportunities developing integrated declarative and procedural knowledge. Relevance and significance of the knowledge component of practica are the motivational aspects that can be developed into further knowledge acquisition once success has been achieved.

- What would be an appropriate structure and format of a vocational curriculum for unsuccessful school leavers?

Practical hands-on activities, creation of learning-by-doing education, initiated on a level below apprenticeships and learnerships, were recommended by the stakeholders and supported by the literature (cf. 2.2.1.3; 4.5.3.1). A transdisciplinary practicum-based mechanical skills curriculum makes provision for progression into vocational education – learnerships, apprenticeships and even NC(V) – lower level skills and entrepreneurships.

The orientation level of the curriculum starts with the very basic procedures and knowledge requirements of mechanical workshop practice. Declarative and procedural knowledge are progressively added, constructing educational foundation and psychomotor capacity upon existing mental representations.

6.2.1.2 Overarching question

What will constitute a curriculum that will afford unsuccessful school leavers an opportunity to construct an educational foundation upon which they can build further capacity?

The questionnaire responses and interviews provided preliminary answers to the research question by motivating the level and educational approach regarded suitable for unsuccessful school leavers' education and identifying the most appropriate institutions to offer the envisaged education. The value of practical hands-on activities as foundation for knowledge construction was also corroborated by the questionnaire data, interview responses and the literature. The latter is confirmed by Woolfolk (2010:258, 259) in an explanation of the acquisition of procedural and declarative knowledge adding why and when to knowing how. Thereby the integrated nature of procedural and declarative knowledge construction was reiterated.

A curriculum for unsuccessful school leavers' education is constructed upon the findings of the research. Delineation of the envisaged unsuccessful school leavers' education constitutes an outline of the relevant education component and supplementing elaboration. Each facet signifies features of the curriculum and concomitant education for unsuccessful school leavers. The following outline puts the curriculum in South African educational perspective:

- Educational field is ***engineering studies***
- Subfield is ***mechanical skills***
- Educational approach is ***transdisciplinary integrated education***
- Educational strategy is ***practicum-based*** presentation focussing on procedures and activities
- Fundamental theory is a ***constructivist learning theory***
- Curriculum focus:
  - Acquisition of integrated declarative and procedural knowledge
  - Development of basic attributes of learning in the engineering field:

    Language
    Mathematics
    Science

Unsuccessful school leavers' education differentiates into four categories of education not necessarily signifying levels: orientation(1), lower level skills development(2), bridging(3) and entrepreneurial skills development(4). The orientation phase will be introductory where the learners will be exposed to the basics and guided into the field of technical education to develop an appropriate foundation for further study. Their progress will determine opportunities and further development.

FET colleges have capacity to spare in terms of facilities and equipment (Interviewees B, C, F, G and N). Incorporating unsuccessful school leavers' education in the college programme establishment will increase learner numbers, make colleges more responsive to community needs and relieve NC(V) educators of the burden of "remedial education" (Akoojee, 2008:4).

Closing the gaps in South Africa's education system should be included in the vision and mission of FET colleges.

FET colleges need a level of education for learners where practical training is the prime focus. Accepting the proposal of this study will pave the way to the development of an educational component catering for a whole spectrum of learners, allowing transfer to institutions with appropriate programmes for specific levels of education foundations, specific aptitudes and cognitive abilities. It will grant schools the luxury of referring poor performers to another institution, but without the detrimental consequences currently affecting learners and NC(V) education.

There is a need for expansion of FET college programme scope. "Increased FET access would have the social benefit of including young people currently not in education, employment or training (NEET) in opportunities to participate by studying in work-oriented programmes" (FET Round Table, 2010:9). A mechanical skills curriculum would be an appropriate addition to the programme scope of FET colleges – a forerunner of more equivalent curricula to come.

According to Van der Berg et al (2011:1), "education [*is*] the only viable avenue for poor people who want to enter the top end of the labour market". This emphasises the need for appropriate education for unsuccessful school leavers to improve their socioeconomic situation, not anticipating the top-end of the labour market, but a niche in the economy.

The abridged answer to the research question is transdisciplinary practicum-based education. Project-based education is one of the approaches utilised in transdisciplinary education in the engineering field, but practicum-based education focuses more distinctly on the procedures signifying learner activities in the processes of striving towards accomplishment of outcomes. Structuring the curriculum according to the unit standards-based OBE enabled distinct differentiation on Bloom's revised taxonomy of learning allowing differentiated development and achievement of qualifications. The units, modules, divisions and levels of the curriculum were therefore, structured accordingly (Appendices J and K).

6.2.2 RESEARCH OBJECTIVES

The data are briefly discussed in the sequence of the research objectives, guided by the quantitative constructs and categories of the qualitative information. Relevant issues from the interviews give the discussion a wider spectrum and providing a deeper understanding of the unsuccessful school leavers' educational situation. These are indispensable to the curriculum situation analysis in division 5.3.

- To give an overview of the international and South African situation with respect to vocational education for unsuccessful school leavers.

In the international arena, second chance education for school dropouts is the remedial facet of dealing with the problem. By improving education quality, European countries succeeded in reducing school dropout. South Africa does not make provision for unsuccessful school leavers or NEET young people. Instead, FET colleges are expected to do "second chance education" (remediation), vocational education and preparation for higher education with the very same educational programmes.

Investigating the opportunities in the educational system of South Africa may contribute towards a better understanding of the educational predicament of unsuccessful school leavers. They enrol in engineering education at FET colleges, regarded as a last resort in further education, which may not have the attributes required for effective unsuccessful school leavers' education. The literature, official statistics and empirical research reveal a situation in FET college engineering studies unfavourable for unsuccessful school-leavers and confirm the necessity of "second chance" education for them.

Another option, short skills programmes at FET colleges, is disqualified as option to unsuccessful school leavers in section 2.5.1 for not complying with the basic requirements of unsuccessful school leavers' education. The empirical research confirmed that conclusion, but further discussion of nonformal education as part of the focus of the FET college sector, was necessary considering community educational needs and unsuccessful school leavers' education as an attempt to address some of these needs.

- To establish the applicable curriculum development and design principles for a vocational curriculum for unsuccessful school leavers.

In Chapter 3 a curriculum theory was formulated and concomitant design theories were established. In the sequence of phases of curriculum development, design, dissemination, implementation and evaluation, only design was in the scope of this study. A seven-stage cycle, which includes a benchmarking facet, was adopted. In-practice-evaluation was not possible due to the restriction to design.

- To determine the typical attributes of unsuccessful school leavers.

Being the principal constituent in the equation, a fair educational profile of the learners is essential in understanding the educational situation of unsuccessful school leavers. It is their poor educational achievements that provoked interest in their educational situation. Without negating psychological, personal and socioeconomic circumstances, the focus is on the educational aspects common to the majority of unsuccessful school leavers.

The rationale of their poor record of learning is revealed by the official statistics, confirmed by the quantitative and substantiated by the qualitative data. They could not progress in school and FET college programmes because they did not learn adequately. With a fair educational profile of the average unsuccessful school leavers established, appropriate outcomes could be formulated to obviate their educational shortfall and design a suitable curriculum and concomitant education. However, the role of the FET college programmes in their educational situation was acknowledged and investigated.

- To identify applicable learning theories and approaches that will foster the design of a vocational curriculum for unsuccessful school leavers.

The basic requirements of an educational approach is suggested in the quantitative survey, confirmed and elucidated in the interviews. A clear picture emerged, which is supported by information from the literature. The educational approach is discussed in greater detail in the relevant facets of the curriculum design.

- To determine perspectives of stakeholders (senior personnel) in the field of vocational education on the attributes of unsuccessful school leavers.

The perspectives of FET college senior personnel and learners in engineering studies were obtained with questionnaires and interviews with personnel. A computer analysis was used to determine frequencies in the questionnaires representing general perceptions about predetermined constructs (Appendix A). Questionnaire data, interview themes and literature information, where applicable, were compared to establish the validity and reliability of the research. The curriculum content of the curriculum was based on the research data.

- To design a curriculum for unsuccessful school leavers according to applicable curriculum development principles, learning theories and empirical data gathered from stakeholders.

From the empirical data a framework for the curriculum and concomitant education was devised. The basic attributes, structure and focus were devised from the data and literature information. The processes of designing the curriculum were developed in the design theory, based on the inferences on the empirical research data and elucidated by literature information. Facets of the curriculum design incorporated in the design theory are discussed in Chapter 3 and the detail expounded on in the relevant chapters covering the different aspects constituting the concomitant education.

The vastly imbalanced candidate/employment prospects situation necessitates the inclusion of entrepreneurship education in the envisaged curriculum for unsuccessful school leavers. The research inquired about both these aspects with valuable contributions by the participants in the empirical facets. Entrepreneurship is an option learners need to seriously consider to broaden their scope of socioeconomic prospects. Supported by literature, entrepreneurships are included as one of the components of the envisaged curriculum.

- To have the designed curriculum for unsuccessful school leavers evaluated by peers (Delphi evaluation method), and adapt the designed curriculum according to the recommendations received.

The curriculum was continuously benchmarked internally during design. External benchmarking was done by educators in industry – Metal and Engineering Industries; Retail Motor Industry; a service provider to SETA's. These recurring processes were supposed to determine credibility and feasibility, which were confirmed by the outcome of the external benchmarking. A composite conclusion to the findings of the panel is attached (Appendix L).

- To propose a curriculum for unsuccessful school leavers.

The research concluded in a curriculum that could provide the type and level of education to accommodate unsuccessful school leavers, providing opportunities and give them hope. This curriculum is only one in a range of envisaged curricula to cover the aptitude and interest scope of unsuccessful school leavers in South Africa.

6.2.3 ADDITIONAL INFORMATION ACQUIRED

The interviews, being open-ended, yield information beyond the requirements of the study. Information about the learners' lack of educational success extended into elaboration on the NC(V) programmes and poor examination successes beyond the scope of the study. Although NC(V) was only investigated for its "appropriateness" as education for unsuccessful school leavers, the additional information enhances the picture of the educational situation of unsuccessful school leavers.

Interviewees also revealed detrimental effects of the lecturers' administrative duties on education. The "paperwork" seems to be a symptom of excessive control hampering education. How the administrative workload contributed to teaching strategies, incompatible with NC(V) programmes, is an unknown factor, but teaching methodology was questioned in some instances. Although the additional information was not targeted, the extended context improves perspective on the educational situation of unsuccessful school leavers. The additional information is utilised in the discussions of relevant sections of the study.

6.3 CURRICULUM DESIGN AND FEATURES OF THE CONCOMITANT EDUCATION

The curriculum is structured according to the design cycle formulated in Chapter 3: situation analysis, formulation of the outcomes, selection of the learning content, fundamental theory and methodology, learning opportunity design, assessment of learning and curriculum benchmarking. Being the investigation facet of the design, the situation analysis constitutes the research reported in Chapter 5. From these data the other design facets are substantiated.

The concomitant education is embedded in the curriculum design (plan) in a fundamental learning theory, educational approach, methodology and assessment. Represented in practicable format in unit standards they feature as the directions on the "route maps" for the "routes" to be pursued in the learning opportunities. Providing "point of departure" and destination, the outcomes guide the education process.

6.3.1 FORMULATION OF THE OUTCOMES

Formulation of outcomes, preceded by the situation analysis, derives its contents from inferences made from the literature study, official documents and situation analysis. The outcomes should describe the competences learners should be able to demonstrate after completion of the relevant learning processes.

Outcomes define the competences learners should demonstrate after completion of the relevant learning processes. National outcomes (critical and developmental outcomes) are overarching definitions of competences acquired in all education in South Africa and are therefore incorporated in the curricula or curriculum statements. Curriculum outcomes describe the competences to be demonstrated after completion of a course. In designing learning opportunities, one or more unit standard outcomes are selected to constitute the aim of the occasion, supported by selected curriculum and national outcomes. The educational needs of unsuccessful school leavers are of paramount importance and should be accommodated in the outcomes.

Analysis of the national (critical cross-field, developmental), curriculum and unit standard (specific) outcomes is necessary to compare the needs of unsuccessful school leavers and the competences defined in the outcomes. Accomplishment of the developmental objectives of unsuccessful school leavers is pivotal in the design of the curriculum. The curriculum must meet the educational criteria established in the research. Embedded in the outcomes are the basics of the educational criteria representing the competences, which should meet the developmental objectives of unsuccessful school leavers.

6.3.1.1 Consideration of national outcomes

National outcomes ("critical cross-field outcomes") are "generic outcomes, which inform all teaching and learning" in South Africa (RSA, 1998:3). They are compulsory for all qualifications registered on the NQF (SAQA, 2006:1). It is therefore imperative to include them in curriculum design.

6.3.1.1.1 Critical cross-field outcomes

Critical cross-field outcomes are generic guidelines for education in South Africa to develop ability to learn effectively, civil responsibility and socioeconomic activity and "promote the full realisation of the potential of every student".

The critical cross-field outcomes are rearranged to represent a developmental pattern. One critical outcome is moved to personal developmental outcomes because it matches these criteria and two personal developmental outcomes are moved to critical outcomes for the same reason.

Greater clarity of the requirements specified in the critical outcomes is obtained by analysing the competences and designating knowledge, skills and values to the outcomes. Easier selection of specific learning processes and learning content needed to accomplish the outcomes is possible with this elaboration. The outcomes are repeated to facilitate referencing.

6.3.1.1.1.1 Knowledge, skills and values designated to critical cross-field outcomes[7]

Learners will be able to:

- communicate effectively using visual, symbolic and/or language skills in various modes.

  Knowledge: Language, Grammar, Drawings, Models, Charts, Relevant Symbols, Rules, Code of Conduct

  Skills: Reading Letters, Literature/Manuals, Reports and Assignment Instructions, Interpreting Drawings; Writing Letters, Reports, Orders, Job Cards; Verbal Communication, Reporting, Discussing, Give Instructions, Explaining Procedure, Utilising Sketches, Models, Charts and Relevant Symbols in Discussions and Instructions, Reflecting on Experiences

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[7] * Outcomes marked with an asterisk are transferred from critical outcomes. Those marked with "black diamond" (♦) are transferred from developmental outcomes.

Values: Respect, Empathy, Honesty, Dedication, Cultural and Language Sensitivity

- use science and technology effectively and critically, showing responsibility towards the environment and the health of others.

  Knowledge: Mathematics, Science, Mechanics, Safety, Pollution, Disposal of Waste Material

  Skills: Calculations, Procedures, Techniques, Precautionary Measures

  Values: Respect, Empathy, Honesty, Dedication, Environmental Wellbeing

- collect, organise, analyse and critically evaluate information.

  Knowledge: Linguistics, Subject Knowledge, Library Procedures, Resource Selection, Source Identification, Analysis Procedures, Interpretation Techniques, Benchmarking Techniques

  Skills: Reading, Sources Search, Compiling Frameworks and Pro forma's, Benchmarking Information

  Values: Respect, Empathy, Honesty, Dedication, Sense of Article (Object) Value

- identify and solve problems and make decisions using critical and creative thinking.

  Knowledge: Subject/Object Knowledge, Equipment and Tools Knowledge, Safety Regulations, Situation Analysis/Diagnostic Procedures, Problem Identification, Analysis Procedures, Information Collection, Solution Selection and Evaluation, Report Writing

  Skills: Reading, Sources Search, Problem Explanation and Discussion, Applying Safety Regulations, Analysing the Situation/Diagnoses, Collect Relevant Information, Evaluate Information, Formulate a Solution, Evaluate the Solution, Correct Application of Tools and Equipment, Solve the Problem, Reporting the Results

  Values: Respect, Empathy, Honesty, Dedication, Commitment, Sense of Article (Object) Value

- work effectively with others as members of a team, group, organisation and community.

  Knowledge: Institution/Company/Community Policy and Ethics, Team Hierarchy, Assignment Detail, Schedule, Work Procedures, Occupational Health and Safety (OHS) Regulations, Personal Responsibility, Members' Responsibilities

  Skills: Discussing the Assignment, Execution of Responsibility, Assisting Team Members, Checking and Responding to Procedure and Application of Safety Measures

  Values: Respect, Empathy, Honesty, Dedication, Self Esteem, Sensitivity for Team Hierarchy, Value Team Members' Attributes, Virtues and Contributions

- demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

Knowledge: Relationships between Field and Environment, Support Systems, Mutual Cooperation, Interdependence, Basics of National and Global Economy, Business Interactions, Market Forces – Supply and Demand

Skills: Consult External Experts, Consider External Aid and Support, Draft a Plan of Action, Select and Schedule a Modus Operandi

Values: Respect, Empathy, Honesty, Dedication, Sense of Personal Worth/Self Esteem, Value Expertise

- ♦participate as responsible citizens in the life of local, national and global communities.

Knowledge: Community Activities, International Activities and Prospects, Relationships amongst Society Members, Societies, Trade, Industry and Environment, Interdependence, Support Systems, Mutual Cooperation, National and Global Societies and Interdependence

Skills: Participation in Education and Training, Participation in Cultural Events, Participation in Sport, Drafting of Personal Goals in Society and Projection

Values: Respect, Empathy, Honesty, Dedication, Sense of Personal Worth/Self Esteem, Cultural Sensitivity, Responsibility

- ♦be culturally and aesthetically sensitive across a range of social contexts.

Knowledge: Cultural Diversity, Historical Context, Cultural Relationships, Cultural Virtues, Interdependence, Mutual Cooperation, National and Global Societies and Interdependence

Skills: Participation in Cultural Events, Participation in Sport, Involvement in Mixed Culture Teams

Values: Respect, Empathy, Honesty, Dedication, Sense of Personal Worth/Self Esteem, Cultural Sensitivity

6.3.1.1.2 Developmental outcomes

The term *developmental outcome* does not distinguish clearly between the two sets of outcomes because the critical cross-field outcomes are also developmental. Developmental outcomes have a more individual personal developmental connotation, and should therefore be labelled *personal developmental outcomes.*

6.3.1.1.2.1 Knowledge, skills and values designated to personal developmental outcomes

- Reflect on and explore a variety of strategies to learn more effectively

Knowledge: Basics of Learning, Learning Strategies, Reading for Comprehension, Memory Techniques, Capturing Data, Categorising Data, Evaluating Data

Skills: Apply the declarative knowledge, Formulate a Goal, Draft a Learning Plan, Select and Schedule a Modus Operandi, Apply Selected Learning Strategies, Apply Reading for Comprehension Techniques, Apply Memory Improvement Techniques; Apply imagination development techniques

Values: Respect, Honesty, Dedication, Commitment, Sense of Personal Worth/Self Esteem

- *Organise and manage themselves and their activities responsibly and effectively

  Knowledge: Personal Attributes and Virtues, Identification Procedure for Strengths and Weaknesses, Vision and Goal Formulation, Mission Formulation, Scheduling and Planning, Benchmarking Procedure for Personal Achievements

  Skills: Evaluate Personal Attributes and Virtues, Identify and Evaluate Strengths and Weaknesses, Formulate a Vision, Formulate a Goal, Draft a Plan of Action, Select and Schedule a Modus Operandi, Exploit Strengths and Improve Weaknesses

  Values: Respect, Honesty, Dedication, Commitment, Sense of Personal Worth/Self Esteem

- Explore education and career opportunities

  Knowledge: Basics of the Labour Market, Fundamentals of Employment, Labour Market and Employment Statistics, Career Basics, Education System of South Africa, Career-Specific Education Programmes, Formative Programmes and Prospects, Admission Requirements

  Skills: Evaluate Personal Qualities, Formulate a Goal, Draft an Educational Career Plan, Select and Schedule a Modus Operandi

  Values: Respect, Honesty, Dedication, Commitment, Sense of Personal Worth/Self Esteem

- Develop entrepreneurial opportunities

  Knowledge: Entrepreneurial Prospects and Statistics, Fundamentals of Entrepreneurships, Educational Opportunities, Admission Requirements, Financial Implications of Entrepreneurships

  Skills: Evaluate Personal Qualities, Formulate a Goal, Draft an Educational Career Plan, Select and Schedule an Entrepreneurial Modus Operandi, Draft a Business Plan

  Values: Respect, Honesty, Dedication, Commitment, Sense of Personal Worth/Self Esteem, Confidence, Responsibility

The knowledge, skills and values designated do not cover the entire scope of unsuccessful school leavers' education or education in general, but these critical cross-field and personal developmental outcomes represent a fair profile of the envisaged citizen and developmental criteria for education.

6.3.1.2 Curriculum outcomes

Curriculum outcomes are curriculum-specific, defining the competences to be demonstrated upon completion of courses. Spady (1994:18) refers to culminating outcomes as synonymous to exit level outcomes, i.e. curriculum outcomes. They are substantiated by the unit standards and realised in the learning opportunities – integrated aspects of education.

6.3.1.2.1 Learner educational needs and outcomes

Unsuccessful school leavers lack the ability to learn effectively. This fundamental ability is incorporated in the curriculum outcomes covering ability to learn, learning strategies and techniques to improve learning capacity. It appears in every unit standard and should be a premise in learning opportunity design. Learning opportunities should accommodate learning methods and techniques and demonstrate effective learning.

Unsuccessful school leavers have poor communication ability (Van der Berg et al, 2011:14). In the curriculum outcomes, communication competences are specified in the communication outcome. The competences essential for learners to learn effectively incorporated in the outcome are reading, oral and written communication complemented by comprehension and rhetoric. Learners need to comprehend what they are reading and hearing to be able to use language really effectively. They further need the ability to express themselves in verbal conversation and in writing to convey their messages effectively. This is one of the areas in which learners lack proficiency, causing problems in communication between them and personnel, hampering development and the effective answering of examination question papers, contributing to poor results.

Comprehension is covered extensively in the curriculum outcomes in terms of logic, deliberation, integrated declarative and procedural knowledge, transfer of knowledge, critical thinking, diagnoses and solutions. These competences are differentiated and assessed according to Bloom's taxonomy of learning to determine levels of accomplishment.

In the curriculum outcomes mathematics is incorporated in the mathematical and scientific procedures relating these proficiencies to practica and expanding the knowledge bases beyond comprehension of the mathematics, science and mechanics involved in the procedures. Mathematics and science are differentiated into the absolute necessities for practica (and projects), higher level cognitive ability to understand features of science and mechanics, and more complex procedures leading to further education, e.g. NC(V).

6.3.1.2.2 Formulation of curriculum outcomes

Development of the skills of unsuccessful school leavers will be done according to the unit standard (specific) outcomes complemented by the curriculum and national outcomes related to the practicum. Achievement of three levels of outcomes in the learning opportunities will require meticulous learning opportunity planning ensuring coverage of all specified information at the conclusion of the unit standard. Acquisition of skills, essential knowledge and values is of prime concern in unsuccessful school leavers' development because the fundamental skills are only preparatory – acquisition of the ability to learn effectively in the subfield of mechanical skills in the mechanical engineering field.

Knowledge, skills and values designated to curriculum outcomes to be pursued are:

- Demonstrate ability to learn and employ strategies and techniques to improve learning capacity.

  Knowledge: *Learning is personal construction of knowledge; Requires a foundation of existing mental representations; Active participation; Learning-by-doing; Acknowledge language, mathematics and science as fundamental to learning; Rehearsal; Techniques to improve memorisation*

  Skills: *Attention; Establish links with prior knowledge; Active involvement in practica; Personal contributions in learning opportunities; Reading for comprehension; Communication; Personal learning/study plan and time table*

  Values: *Personal responsibility; Commitment; Vision; Conscientiousness*

- Demonstrate ability to communicate effectively through oral and written presentations, supported by reading, comprehension and rhetoric/discussions.

  Knowledge: *Grammar; Syntax; Vocabulary; Composition and Punctuation*

  Skills: *Verbal communication; Pronunciation; Listening; Reading; Comprehension; Writing and Succinctness*

  Values: *Courtesy; Wit; Humour; Conciseness*

- Demonstrate ability to derive logical conclusions from deliberations on information.

  Knowledge: *Interpretation; Identification of relationships; Comprehension development; Imagination development; Critical thinking development,.*

Skills: *Critical thinking; Recognition of relationships; Logical organisation of thoughts; Composition of conclusion*

Values: *Appreciation of knowledge, language, mathematics and science; Honesty; Empathy; Commitment*

- Demonstrate practical application of integrated declarative and procedural knowledge in task execution.

  Knowledge: *Remember, understand and apply (first three levels of Bloom's revised taxonomy of learning)* (cf. 4.3.1); *Tools and equipment; Procedures and precautions*

  Skills: *Apply declarative and procedural knowledge in calculated execution of tasks*
  Values: *Value property, tools and equipment; Appreciation of scaffolding and peer support; Devotion*

- Demonstrate the ability to transfer knowledge from a specific task to differing applications.

  Knowledge: *Applicable knowledge; Relevance; Frames of reference*

  Skills: *Comprehension; Imagination; Adaptation; Application*

  Values: *Appreciation of knowledge; Dedication; Vision*

- Demonstrate capacity to perform the mathematical, scientific and mechanics calculation procedures involved in projects, but not limited to direct applications.

  Knowledge: *Applicable mathematics, science and/or mechanics; Relevance and applications; Related further development in any of these fields (subjects)*

  Skills: *Identify calculations in procedures; Apply correct calculation*

  Values: *Appreciation of knowledge; Commitment; Vision*

- Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.

  Knowledge: *Declarative and procedural knowledge involved in execution; Safety regulations and procedures; Tools and equipment; Workshop procedures*

  Skills: *Interpretation; Information collection; Planning; Execution procedures*

Values: *Appreciation of property, tools and equipment; Safety concerns about self and others; Respect; Dedication; Perseverance*

- Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.

  Knowledge: *Interpretation; Identification of relationships; Comprehension; Imagination; Critical thinking; Problem-solving methods.*

  Skills: *Critical thinking; Logical organisation of thoughts; Spatial manipulation of mental images; Problem solving*

  Values: *Appreciate logic, relevance and structure; Honesty; Dedication; Gratitude*

- Demonstrate the ability to diagnose systematically, identify defects and propose feasible solutions, convert them into executable plans and solve problems.

  Knowledge: *Function, construction and operation of machine or component; Diagnostic apparatus; Procedures; Symptoms*

  Skills: *Diagnostic plan; Operate Diagnostics apparatus; Identify symptoms; Interpret symptoms; Diagnose and identify defects; Propose plan of action; Systematic execution of correctional procedures; Imagination*

  Values: *Value property, tools and equipment; Dedication; Perseverance; Conscientiousness; Reliability*

Learning/curriculum outcomes must be adjusted, guided by the unit standards, to the level and category of education of the learners. Four categories of education for unsuccessful school leavers are identified: orientation, bridging to further education, lower level skills and entrepreneurships. Development, acquisition of unit standards and extended knowledge levels will eventually be the determinants of category, further development and future educational route for unsuccessful school leavers. Unit standard outcomes are formulated in the relevant subdivision of the curriculum. Several elements, such as learner educational performance, learning barriers and educational disposition need serious consideration in learning opportunity design. Determining these "premises" is actually defining the "destination" of the curriculum and the "destination" of each learning opportunity.

6.3.1.2.3 Unit standard outcomes

Unit standard outcomes define the specific competences needed in the execution of practica. They contribute to achievement of curriculum and national outcome competences and all three outcome-levels accumulate towards a level qualification.

"What is worth doing?" is essential for these learners to guide them towards the aim of their specific category of unsuccessful school leavers' education – core learning. Answers to this question are derived from the questionnaires and interviews. "What is worth doing?" must be followed by "Which knowledge and values will enhance their skills and personalities?" From the collected information, the curriculum outcomes and substantiating knowledge, skills and values are formulated. These outcomes are represented in the unit standards (Appendix K). The relevant knowledge, skills and values are specified in the outcomes and corresponding divisions of the unit standard.

The unit standard outcomes make provision for different levels of development and accomplishment, which is also reflected in the unit standard assessment criteria. Minimum requirements are set for different levels, but development beyond the highest level should be encouraged because learners with a desire to re-enter further education should be allowed the opportunity for optimum achievement.

6.3.1.2.4 Incorporation of outcomes in the curriculum

Critical, personal developmental and curriculum outcomes are incorporated in the unit standards as criteria for the competences learners should demonstrate after completion of curriculum units, modules, levels and courses.

Ability to learn is incorporated in the personal developmental outcome dealing with strategies to learn effectively. This personal developmental outcome is differentiated into:

Knowledge

- Basics of learning
- Learning strategies
- Reading for comprehension
- Memory techniques
- Data capturing techniques
- Categorising data
- Evaluating data

Skills

- Apply the declarative knowledge
- Formulate a goal
- Draft a learning framework
- Select and schedule a modus operandi
- Apply selected learning strategies
- Apply reading for comprehension
- Exercise memory improvement techniques

Values

- Honesty
- Dedication
- Commitment
- Perseverance
- Sense of personal worth/ self-esteem

A higher level of learning, denoting research, is presumed by the relevant critical outcome referring to collection, analysis, organisation and evaluation of information. In a very elementary format, this can be achieved by unsuccessful school leavers.

Linguistic proficiency relates to the critical outcome of communication. The outcome incorporates a variety of communication modes and therefore knowledge from different subjects (sub disciplines) or knowledge clusters is required. Some of the following knowledge clusters represent forms of communication other than language:

Knowledge	**Skills**	**Values**
▪ Language ▪ *Drawings* ▪ *Communication aids: models, charts* ▪ *Relevant symbols* ▪ *Rules/Procedures* ▪ *Code of conduct*	▪ Reading ▪ Writing ▪ Verbal/Discussion ▪ *Drawing* ▪ *Interpretation of drawings* ▪ *Use communication aids*	▪ Respect ▪ Empathy ▪ Honesty ▪ Dedication ▪ Cultural and language sensitivity

Mathematical proficiency is not specified in the national outcomes, but is included in the analysis because it is a prerequisite for science education. The critical outcome, designating effective use of Science and Technology, is differentiated into knowledge of mathematics, science, mechanics, safety and pollution (applied science) with related skills and values.

The outcomes discussed above signify a framework of fundamental declarative and procedural knowledge required for a sound educational foundation for effective learning and further development of unsuccessful school leavers. Accomplishing the aim of the curriculum, however, necessitates addition of core learning for comprehensive declarative and procedural knowledge (knowledge, skills and values) development. The core ("vocational") learning comprises orientation towards engineering (technical) education, lower-level skills, preparation for vocational education (learnerships, apprenticeships and NC(V) programmes) and entrepreneurships.

Critical and developmental outcomes do not specifically refer to comprehension, but this is included in the analysis because problem-solving, decision-making, critical thinking, creative thinking and interrelatedness of reality require thorough understanding of the incorporated information. It is, on the other hand, a presumption for the mentally higher order competences denoted by the outcomes. Being overarching, the national outcomes do not cover the specifics of knowledge, skills and values development. The competences dealing with the detailed requirements belong in the unit standard outcomes – elaborations of curriculum outcomes (Appendix E).

6.3.1.3 Outcomes, units, modules and qualifications

Within the structure of the curriculum, outcomes define the competences learners should acquire through participation in the practica constituting the learning opportunities. Learning opportunities and concomitant practica are constructed from the outcomes contained in the units: unit standard, curriculum and national outcomes. Learning opportunities are progressive steps towards achievement of units, building on one another until the requirements of the unit are met.

Units accumulate into modules and the modules into divisions and curriculum levels. Within a curriculum level differentiation is possible with criteria derived from Bloom's revised taxonomy of learning outcomes and the specific units accomplished (cf. 4.3.1). The type of qualification achieved is determined by these criteria and the level accomplished. Unsuccessful school leavers education differentiates into the following qualifications: orientation(1), lower-level skills(2), bridging into learnerships, apprenticeships and NC(V)(3) and entrepreneurships(4). At the heart of it all are the processes of learning that require learning content and opportunities to accomplish the desired competences. Content is the information from which the learners can construct declarative and procedural knowledge required to satisfy the criteria of the outcomes.

6.3.2 LEARNING CONTENT SELECTION

In unsuccessful school leavers' education, learning content is contained in projects and structures of the practica implying correlation with the outcomes prescribing the competences and embedded knowledge. Aligning the learning content in the practica with the content presumed by the outcomes, is essential in pursuit of effective education and accomplishment of the outcomes.

Knowledge, skills and values (declarative and procedural knowledge) constitute the basics of the learning content required for accomplishment of the outcomes. Unsuccessful school leavers need a hands-on approach to launch learning opportunities disseminating into procedures (skills), knowledge and values. Practicum-based education necessitates meticulous selection of the projects that can provide the opportunities for specified skills, knowledge and values acquisition developing into desired competences.

The selected projects are specified in the curriculum layout and elaborated on in the unit standards (Appendix K). Identifying the learning content provided by the projects enables comparison with the requirements in the outcomes and evaluation according to the criteria.

Unsuccessful school leavers education covers the knowledge requirements for standard mechanical workshop practice and project procedures. Essential basic knowledge includes workshop (or practilab) practice; standard practicum procedures; workshop, people and personal safety; identification and handling of tools and equipment applicable to all tasks. Declarative and procedural knowledge are incorporated in the *knowledge, skills and values* aspects of the education.

Three distinctive basic characteristics of appropriate learning content are mentioned denoting relevance, significance and purpose, relating it to the outcomes. Knowledge is constructed on relevant existing mental representations signifying progressive building of knowledge structures enabling further knowledge construction. The knowledge incorporates declarative and procedural knowledge – knowledge, skills and values.

Constructing a significant learning opportunity with the selected learning content necessitates presentation complying with sound educational practice. Learning content is a commodity in presentation, learning opportunities and education in general. Criteria for careful selection of this commodity can enhance the process and lay the foundation for effective learning.

6.3.2.1 Content for unsuccessful school leavers' education

Learning content will be determined by the projects constituting the framework of possibilities derived from a list of viable subfields provided by the personnel respondents. Each project will incorporate knowledge that can develop language, maths, drawing, chemistry, materials, physics, mechanics and "life orientation" (safety, social attributes, working in a team, values and attitude). More complex projects will obviously encompass more knowledge.

The educational/approach preferences of the stakeholders point towards hands-on activities denoting workshop practical education. From their comments and list of entrepreneurial prospects metalwork with emphasis on welding, remove and install motor vehicle components, maintenance, elementary repairs and primary diagnoses are included in the curriculum. From these other content to honour the obligations of the curriculum regarding language, mathematics, science and mechanics are derived.

6.3.2.2 Criteria for learning content selection

Learning content is selected according to criteria established before serious consideration is given to procedure. The criteria involve outcomes analysis to establish the learning content (information) requirements of the outcomes and aligning the content selection criteria with the outcome requirements. Carl (2010:77) infers from Carl et al (1988:30), "Learning contents should be analysed in the light of the following: linking up with objectives, extent, relevance, degree of difficulty, available sources, demands and requirements of the syllabus, depth of study, classification, time-scheduling, textbooks available, other available learning content, suitability for relevant learners, and structure of the subject content." The process in unsuccessful school leavers' education follows a "design down" approach, analysing the outcomes to determine the learning content requirements and endeavour to meet these requirements with application of selection criteria.

The learning content of unsuccessful school leavers' education must comply with the requirements of the outcomes, but also in more detail with the specific type of education derived from the fundamental learning theory and the research results. Learning must be real integrated experiences of declarative and procedural knowledge construction. Learners should construct relevant declarative knowledge while they are executing the task, thus constructing procedural knowledge. The unsuccessful school leavers' learning content encompasses the following characteristics:

- Be practicum-based
- Linked to prior knowledge – built on a foundation of existing mental representations
- Represents integrated declarative and procedural knowledge
- Distinctly identifies the declarative and procedural knowledge represented
- Be comprehensive enough to satisfy the requirements of breadth and depth enabling accomplishment of the different levels according to Bloom's revised taxonomy of learning outcomes

Guiding selection of learning content and considered by Carl (2010:33) as incorporated in the curriculum framework, is the core learning content. From the core content, incorporated in the unit standards and the outcomes, learning content can be derived that can expand the information base of learning opportunities to cover more than the requirements of the unit standards (expansion of content for differentiated levels of outcomes). Core learning content to be covered is prescribed in the unit standards (Appendix K).

The learning content for unsuccessful school leavers' education covers the requirements for an introduction in technical education(1), lower level skills occupations(2), bridging into learnerships, apprenticeships and NC(V)(3) and entrepreneurships(4). It includes the very basics of workshop practice in the first levels of the first strata of declarative and procedural knowledge construction. On the adapted revised version of Bloom's taxonomy, it covers the first two levels, LAC 1 and LAC 2. Further development beyond the criteria of the unsuccessful school leavers' curriculum will be allowed, leading to the expansion of learning content into fields of interest. The basic requirements in terms of knowledge, skills and values, incorporated in the unit standards, are deduced – not copied – from the NC(V) 2 *Engineering and Related Design* and *Fundamental* subject guides (Department of Education, 2006a). These requirements also cover the entry requirements of learnerships, apprenticeships and NC(V), one of the higher levels envisaged for unsuccessful school leavers' education.

Learning material, incorporating a project in unsuccessful school leavers' education with its practical hands-on orientation, constitutes the core providing the opportunities for comprehensive and progressive learning and development. The project initiates the selection of the learning material required for successful completion (cf. 4.5.3).

6.3.2.3 Sources containing learning content

Carl (2010:31, 90) gives a list of possible sources where learning content (information) can be found: "textbooks, subject literature, articles, notes, self-activity modules, various educational media and others". Only core content is included in the curriculum and educators should do the learning content "hunt" themselves. In addition to these sources, syllabi and/or subject guides of learnerships, apprenticeships and NC(V) are useful in determining their entry requirements to serve as guidelines for content in the bridging component of unsuccessful school leavers' education.

In unsuccessful school leavers' education the practica, and more particularly the projects, provide the motivation (reasons) for acquisition of (or search for) learning content (information) that can enable declarative knowledge construction and provide the means for procedural knowledge development. The learning content required for declarative knowledge construction, which includes the information necessary for procedural knowledge development, is available in the sources mentioned by Carl (2010:93), workshop manuals and Occupational Health and Safety (OHS) regulations (RSA, 2011). The latter provide much information about the procedures to be followed.

6.3.2.4 Project analysis and learning content assembly

Project analysis in unsuccessful school leavers' education is a matter of matching the selected projects with those prescribed in the unit standards. For the projects in the unit standards, the basic procedures are listed, requiring only methods, techniques (procedural information) and declarative information to be incorporated in the practica and therefore in the learning opportunities. Selection of procedural and declarative information is guided by interpretations of the three levels of outcomes listed in the unit standards. The procedures and information required by the selected projects must correlate with those listed in the unit standards.

In the analysis of the project and practicum, emphasis must be on knowledge construction fundamental to educational foundation construction, i.e. language, mathematics and science.

However, declarative knowledge of procedures and procedural knowledge construction are equally important, but are, unlike the former, naturally incorporated in the practicum.

6.3.2.5 Curriculum outcomes analysis and learning content selection

Learning content identification in outcomes is easier when outcomes are analysed into the declarative and procedural information in terms of information (knowledge), skills (procedures) and values (predisposition). Provision must also be made to accommodate learning on differentiated levels according to Bloom's revised taxonomy of learning outcomes. The national outcomes are analysed above (cf. 5.3). Curriculum outcomes are analysed accordingly (below), but unit standard outcomes, describing the basic procedures and concomitant information are in the domain of the educators' responsibility of designing and executing practica in learning opportunities. They must be considered in conjunction with the core learning content.

The requirements of the curriculum outcomes are elucidated by analysing the competences and designating knowledge, skills and values to the outcomes. Selection of learning content needed to accomplish the outcomes, is made easier with this elaboration. The outcomes are repeated to facilitate referencing.

The analysed national (critical and developmental) and curriculum outcomes, in addition to the unit standard outcomes and core content, provide the means for a layout from which the learning content can be selected. It is, however, necessary to align these with the requirements of a relevant project for the final selection of learning content. The project and associated practicum provide the opportunities to accomplish the competences in terms of knowledge, skills and values prescribed by the outcomes. Through selection of projects that can satisfy the requirements of the outcomes (What is worth doing? and, What is worth knowing to enhance the doing?) and aligning the learning content requirements of projects and outcomes, practicable units are constructed. Unit standard outcomes further guide the learning content selection and facilitate the design of learning opportunities for effective learning.

It is the responsibility of educators to compile learning content lists and criteria for the learning opportunities. Learning content sources are listed in 5.5.1.3 above.

6.3.2.6 Benchmarking content against outcomes/criteria

The analysed national and curriculum outcomes, unit standard outcomes, core content and learning content criteria provide the benchmark to verify comprehensiveness, breadth and depth of selected learning content. Meeting these criteria is an indication of covering the requirements of the curriculum including the needs of unsuccessful school leavers. It should also allow for learner differences in mental capacity, aptitude and abilities.

Learning opportunity design pro forma should include a benchmark for learning content as one of the measures of learning standard attainment – attainment targeted. Learning content includes the declarative and procedural information required for effective learning – construction of declarative and procedural knowledge or in South African OBE terms, acquisition of knowledge, skills and values.

6.3.3 FUNDAMENTAL LEARNING THEORY

Fundamental theory is the foundation of learning (the essence of education) engendering stature, credibility, efficaciousness and significance in education. Constructed upon a fundamental learning theory, it renders methodology structure, purposefulness and effectiveness (CF. 3.4.5).

6.3.3.1 Constructivist learning in context

Learners develop best in situations with interaction where they create their own constructs of the world/reality/environment. They make moral judgements based on their own observations. Experience is knowledge acquired through interaction with the world/environment/learning content. These features are common to all the approaches to education mentioned above, but in the constructivist paradigm, Piaget (1975:6) formulated key concepts that explain development and more specifically, mental development, in greater detail. Teaching is always indirect. Educators can only be facilitators of the learning process regardless their approach. The prime consideration is ***the best way to facilitate learning***, e.g. lecture, discussion, role-play, demonstration, problem, project or practicum. The distinction between the last two is in the focus: focus on the project (physical object) or procedure (practicum).

Educators create learning opportunities, but cannot put knowledge into the brains of the learners like putting matter into a container. The "mental structures" the learners possess enable them to assimilate external events and transform them to fit their internalised knowledge – building knowledge structures through progressive internalisation of actions on a foundation of existing mental representations (Bhattacharya and Han, 2009:1 of 7).

Resistance to learning is a reality and conceptual changes do not come easily. Knowledge must be presented in a consumable format, significant to the learners and associable with internalised knowledge. The internalised knowledge of learners is embedded in a framework of cultural heritage (knowledge is situated) essentially an integral part of the context in which the learners should construct their own version of the learning opportunity and content. The role of context, importance of learner involvement, uses and media cannot be overlooked. They are essential for successful learning opportunities.

Learning continues in settings other than institutionalised learning opportunities. "[L]earning essentially occurs in interaction with a social and cultural context and artefacts, and especially through participation in cultural activities and practices" (Elen, Louw, Rosseel, Schippers, Van Wyk and Van Wyk, 1999:36). Taking these into consideration in learning opportunities can enhance the learning atmosphere and environment.

Responsiveness to the context of knowledge is essential to maintain relatedness. Feldman and McPhee (2008:419) emphasise the importance of and role of context in learning. Referring to differences in settings, they mention a lack of uniformity in teacher training signifying the importance of context. Knowledge is embedded in situations in which it is constructed and actualised and should not be detached from it. Learning opportunities and the environment created for the occasion form the immediate context of learning, but the learners bring their internalised knowledge, including cultural heritage into the setting. Knowledge structures are built through progressive internalisation of actions – simultaneous construction of declarative and procedural knowledge upon existing mental structures (active involvement) with cultural attributes incorporated. It is shaped by uses, external support and media, often to the point of automation into procedural knowledge.

In the frame of approaches to education, OBE, project-based, problem-based and transdisciplinary education were selected because they nurture these characteristics presumed valuable for unsuccessful school leavers' education. However, integration in this perspective does not feature in the approaches, but transdisciplinary educational approach and project/problem-based education get very close.

Educators are concerned about appropriate knowledge, its validity and application (skills) – "knowing that" (knowledge) and "knowing how" (utilisation and skills). For the purpose of this study, "knowing why" must be added because the significance of the knowledge is important for the selection of the curriculum content and the translation into skills. "Knowing how", procedural knowledge, is emphasised in learning-by-doing without disregarding the importance of declarative knowledge (knowing that/what/why), cognitive processes and cognitive development. "Why", however, has a connotation of value and affection, slightly different form pure declarative knowledge or procedural knowledge. The psychological processes of learning are important to educators because they are fundamental to teaching principles and strategies.

Epistemology distinguishes between knowing (awareness – knowing that/what) and handling/utilisation of knowledge (know how). How knowledge is acquired will arouse interest and become significant if theory is translated into practicable information. The acknowledgement of the dynamics of knowledge by epistemology is another point of interest to educators. Knowledge is relative, evolutionary and personally constructed. These brief discussions emphasise the necessity of a fundamental theory of learning for the design and construction of the curriculum, learning opportunities and practica. These activities need a sound foundation to provide the validity and cogency to the curriculum, learning opportunities and practica.

A transdisciplinary practicum-based educational approach for mechanical skills encompasses the features required for unsuccessful school leavers' education. Acquisition of declarative and procedural knowledge resides in practica. Circumnavigating subject focus diminishes the deterring effect of weaknesses in mathematics, physical science and language and permits steady building of knowledge structures, competence and confidence. Integrated acquisition of declarative and procedural knowledge forges links, relationships, applications and frames of reference. Significance and purpose of knowledge are established, enhancing utilisation – "what learners can do with the knowledge acquired".

The unit standards-based structure provides the features necessary for the transdisciplinary-integrated approach. It facilitates differentiated development of learners and construction of qualifications. Differentiation according to mechanical skills level and perceptual-motor and cognitive development is possible with the addition of criteria based on a revised version of Bloom's taxonomy of learning. Extending knowledge beyond the confines of practica is also facilitated by the curriculum structure. Learners can satisfy needs and curiosity – the requirements for further development and personal interest.

Achievements are classified according to mechanical skills levels and an adapted version of Bloom's taxonomy of learning, constituting different levels and permutations of integrated declarative and procedural knowledge. Further development of learners can be recommended according to these classifications revealing ability, aptitude and level of cognitive and perceptual-motor accomplishments.

6.3.3.2 Knowledge differentiation for unsuccessful school leavers' curriculum

Declarative knowledge comprises the rules, theories and everything worth knowing **about** the objects/events/aspects involved in learning. These are incorporated in the knowledge specifications of the unit standards. Differentiating the knowledge into different strata is necessary to provide a procedural structure and essential sequence for the execution of practica (cf. 4.2.3).

Every project procedure is divided into preparation, execution and evaluation, requiring specific declarative knowledge. Bloom's adapted taxonomy of learning outcomes can be applied within the structure of the knowledge representation of strata differentiating levels of accomplishment.

The strata levels/stages of declarative and procedural knowledge follow the same logical sequence for the same reasons. A following level is structured upon the preceding level accomplished and the fundamental learning theory postulates construction of new knowledge on relevant existing mental representations. Sequencing of the strata of declarative knowledge is a logical and practical arrangement because it follows standard workshop procedures, making provision for precautionary measures before venturing into execution of tasks and concluding with evaluation of the execution. It is furthermore compliant with the fundamental theory of learning, requiring relative existing memory content (mental representations) essential for the construction of new knowledge. It is therefore recommended that a stratum be accomplished before moving to the next level. Ethics (values and conduct) are included in each stratum.

The different strata of declarative knowledge for the envisaged education are:

- The first stratum comprises the knowledge fundamental to basic execution of tasks in most learning activities. It can be communicated and demonstrated to learners. It cannot be taken for granted that learners know these basics. Incompetence can cause failure and can be dangerous in manual arts and crafts. It essentially incorporates knowledge beyond the safety, procedures and bodily manoeuvres involved (e.g. knowing the construction of a spanner, the design features, torque implications – mechanics, science, mathematics and language).
- Knowing the rules, safety, precautions, theory, function, construction, procedures and techniques of a task, including the operation of components of a project, constitute the second stratum of knowledge. This stratum is more readily communicated to learners because it is normally included in the curriculum. In the case of unsuccessful school leavers it is important to include the *knowing why*. Give the learning more meaning by communicating reason, relationships, examples and situations.
- Measuring instruments, adjustments, measurements, calculations and reporting the results constitute the third stratum of declarative knowledge in unsuccessful school leavers' education. Handling the admin, reading and interpreting manuals and doing the necessary

calculations involve language, basic science, mathematics and basic accounting – *knowing why* included.

- Diagnosis, interpretation, evaluation, problem solving and communication in the fourth stratum require extensive knowledge of the field and bridge the boundaries into various other fields/subjects (transdisciplinary). Problem solving and diagnoses rely heavily on comprehensive knowledge of construction and operation of components/projects. At this stage, learners can get involved in peer guidance and mentoring. Accomplishment of proficiency opens the doors to further development in the topics covered and other fields (subjects) of interest (cf. 4.2.3; 4.3.1).

Procedural knowledge comprises the capacity to carry out the procedures involved in execution of tasks: methods, techniques, measurements, calculations, precautions and conduct. Much of these become automated (unconsciously executed). Procedural knowledge occurs in three stages: cognitive, associative and autonomous. The cognitive stage is execution of a task depending on deliberate conscious mental processes initially utilising declarative knowledge to establish associations and muscle reflexes. During this stage of perpetual-motor development, links are established between mental representations and motor (muscle) activities. Execution of psychomotor activities still requires conscious deliberate utilisation of declarative knowledge during the associative stage in the process of developing relevant mental scripts. Concluding the associative stage with repetition until automation of the psychomotor processes is accomplished, finalises this stage of perceptual-motor development. During repeated execution most of the activities become automated (cf. 4.2.3; 4.3.1).

Learning procedural knowledge is a process of converting knowledge into skills – mobilisation of knowledge, *know how* into *capacity*. Initially the whole procedure is cognitively executed until association of rules and precautions, and some psychomotor activities, become automated. Accomplishment of procedural knowledge is demonstrated by transfer to different situations. Each stratum is built on the competence of the preceding one. Deliberate compliance to the ethics (values and conduct) is required in every stratum.

The different strata of procedural knowledge for the envisaged education are:

- In procedural terms, the first stratum is the capacity to execute the basic procedures of a task. It involves the mobilisation of the mental representations into appropriate muscle actions and bodily movements – active execution of the physical processes involved, e.g. intellectual skills: writing, riding a bicycle, driving a car, some computer manipulations; and perceptual-motor skills: playing tennis, doing ballet, typing, exercising a craft and imitating a demonstration, to name but a few (Jordaan and Jordaan, 2000:470, 478). It is difficult to communicate these processes to learners because they have to physically accomplish the capacity themselves, by executing the various actions.

- The capacity to apply the rules, safety, precautions, theory, construction, procedures and techniques of a task – self-constructed perceptual-motor knowledge – is the second stratum in procedural knowledge. Active involvement of the learners in meaningful exercises – fundamental to practica – to mobilise the procedural knowledge into capacity and level of competence, demonstrated in behaviour, is essential.
- The methods, techniques and procedures to do adjustments, measurements, calculations, reporting, administrative tasks and accounting constitute the capacity (knowing how – procedural knowledge) in the third stratum of procedural knowledge differentiation. At this stage learners should exercise (learn) the procedure with emphasis on detail and precision.
- Procedural systematic execution of diagnostics, interpretation, evaluation and problem solving with determination and precision constitute the fourth stratum. Much of the basic psychomotor activities will become automated – unconsciously executed. Developing the "gut feeling", fine-tuning or judgement and logical systematic execution of tasks reveal accomplishment of competence. Accomplishment of this level of procedural knowledge development equates to intellectual skills (cf. 4.2.3; 4.3.1).

Procedural knowledge cannot be acquired effectively by observation. To accomplish procedural knowledge active execution of the processes involved should be mastered. Sensory stimuli (information) and motor activities need to be coordinated, e.g. hand-eye coordination. A procedural network of knowledge incorporates application (knowing how) of rules, safety, tools, theory of the component, measurements, calculations, procedure and technique. It is dexterity at the disposal of the expert.

Motivation, knowing why including the ethics involved, is an essential addition to unsuccessful school leavers' education. Learners need to know why each and every aspect of the curriculum is essential, e.g. a step or link to more complex learning or their social, vocational and personal development. Motivation manifests in attitude and conduct.

6.3.4 METHODOLOGY

Methodology is a system of "principles," premises, "methods," "techniques" and tactics, guiding education practice (Plug et al, 1993:219; Butterfield et al, 2003:1026; Collins and O'Brien, 2003:220). Signifying the procedure of education, methodology is at the heart of learning opportunity strategies. How to go about effectuating a learning opportunity (method) is determined by the desired outcomes, selected project and practicum. Converting the planned activities of a practicum into effective learning can be accomplished with appropriate methods and associated techniques.

The psychological processes of learning, most suitable for unsuccessful school leavers' education, will determine the educational approach, strategies and methods. Methodology cannot be detached from the fundamental learning theory. The fundamental learning theory provides the substructure, premises and principles for the strategies and education within the broader frame of the curriculum.

It can be concluded from Feldman and McPhee (2010:38) that "application" of the fundamental theory, strategies and educational approach should be "apparent". This theory must find active, appropriate application in a suitable curriculum to be conducive to effective learning and education. Constructing a curriculum on this foundation necessitates inclusion of attributes from existing educational models within a complementary education approach. Methodology to correspond with educational fundamentals, learner needs and established context focuses the study on competency-based educational models.

6.3.4.1 Significant attributes of educational models

Significant attributes of other educational models can contribute to the quality of the envisaged education. Correlating these features with the fundamental learning theory and educational situation of unsuccessful school leavers affords the opportunity to formulate an approach signifying methods and techniques of education with the attributes conducive to learning – matching the needs of unsuccessful school leavers.

A few competency-based approaches are considered for the contributions they can make to the mechanical skills education envisaged for unsuccessful school leavers (cf. 4.5). Their education requires methods that can overcome the aversion to academic learning of such learners and accommodate learner differences for effective learning with the emphasis on learning.

6.3.4.1.1 Attributes of OBE

OBE emphasises the outcomes of education. What learners *can do with the acquired knowledge* is essential. Focusing on learner performance and accomplishment replicates learner-centred education. The purpose of knowledge emphasised by OBE is important. Adding "knowing why" to the purpose of knowledge, is a significant contribution providing motivation and relevance.

"Clarity of focus" is very important to unsuccessful school leavers' education. Learners (and educators) need to be focused on the knowledge, skills and values to be acquired. Every learning opportunity needs to contribute to cognitive, perceptual-motor and ethical development of learners. Learning outcomes focus attention on these aspects.

Progress in small steps (practica, projects and units) and recording of these accomplishments, permit differentiated advancement through the curriculum. Improved performance of "all" learners, especially the less prominent achievers, can be accomplished without neglecting the top performers. Differentiated accomplishments are also possible.

Assigning greater responsibility to the learners for their own education, OBE makes education a partnership between learners and educators. Learner involvement, greater cooperation and improved relationships can benefit education and the development of unsuccessful school leavers.

6.3.4.1.2 Attributes of project-based education

Project-based education employs projects to create learning and discovery opportunities for learners, providing inviting, encouraging and procedural functional learning experiences. Hands-on education is a method directly related to project-based education where physical objects are utilised. The learners learn by seeing, feeling, handling, dismantling, assembling and building projects, constructing their own knowledge through these experiences.

Practicum is a learning-by-doing experience for learners. Focussing learner development on execution of the procedures – what learners actually can do and how integrated declarative and procedural knowledge develops into intellectual skills, distinguishes practicum-based education for project-based education.

6.3.4.1.3 Attributes of a transdisciplinary education integration model

Transdisciplinary learning is dynamic in approach and execution. It is experiencing reality in its diversity, complexity, dynamics and gestalt. Aligning learning with a fundamental learning theory and real-world situations signifies a natural phenomenon conducive to holistic cognitive and perceptual-motor development. A transdisciplinary approach constitutes the learning opportunity arrangements to utilise practica as bases for information detection and knowledge acquisition in real *learning-by-doing* education with learning beyond the confinements of the project.

The transdisciplinary approach to education provides the opportunity to circumnavigate learners' aversion of an academic approach to education and inability to transfer knowledge to other applications. Knowledge, declarative and procedural, is constructed in the practica from the information requirements of the projects. A practicum originates in the project selected for its potential to provide the opportunities (requirements) of information collection and construction stipulated in the outcomes.

The term *practicum* gets precedence because it emphasises learner involvement and activities. Learner activities include collection of information from different subjects/disciplines and constructing personal declarative and procedural knowledge. Studying reality in the facets concerned from the environmental/situational perspective complements relevance, significance and knowledge construction. Therefore, ***practicum-based learning, in the context of transdisciplinary education, is considered the approach that has the attributes needed for the envisaged unsuccessful school leavers' curriculum.***

6.3.4.2 Conclusive reflection

The approaches discussed all share a common factor: active involvement of the learner in the learning process, resulting in competence. The methodology for unsuccessful school leavers' education is based on a learner centred, practicum-based and transdisciplinary-integrated educational approach and practice. Learning opportunity strategies comprising *practica*, based on projects specified in the curriculum, denoting ***active learners constructing declarative knowledge while developing procedural knowledge***. It allows successive levels of progressive education starting with the concrete through representational to abstract.

The approach selected is ***transdisciplinary practicum-based education*** to obviate the negative connotation of (certain) subjects, improve participation by hands-on activities, and provide relevance and significance to learning content. This hands-on, active-learner education presents the opportunity of real learning-by-doing and application of knowledge to real life situations. In mechanical skills, the projects are primarily mechanical devices and components for repairs or building of equipment and commodities. The learning opportunities are planned in such a way that the desired outcomes can be achieved – the desired competences acquired.

Educational methods are common knowledge to experienced educators, but practicum-based education limits the selection to a few appropriate to the transdisciplinary practicum-based approach. Practicum-based education dictates selection of practicum method, which complements group work, cooperative learning or problem solving as methods depending on the outcomes. A variety of techniques can be added to support the selected method. The key aspect in the selection of methods and techniques is practicability. Execution and results should replicate efficiency.

A teaching strategy is a comprehensive plan for the execution and effectuation of the "offensive" against ignorance and incompetence. In military terms, this "is the art and science of the planning and conduct of war" (Butterfield et al, 2003:1595). In educational terms a strategy encompasses the planning and mode of execution of practica, the procedures of the learning opportunity.

Underlying curriculum methodology is a constructivist learning theory constituting the principles and premises of unsuccessful school leavers' education (cf. 4.2.2).

6.3.4.3 Principles and Premises underlying methodology derived from the fundamental learning theory

Education is about effective learning facilitated and scaffold by educators in learning opportunities. Effective learning is guided by educational principles and premises derived from the fundamental learning theory and the research data. Educational principles and premises are didactically orientated statements focussing the educational process (learning) on the learners and presentations. The following principles serve as didactic guidelines:

- Learners construct their own knowledge from information and experiences they are committed to and involved in.
- Learners are holistically involved in learning – cognitive, perceptual-motor, affective and volitional (Krüger and Müller, 1990:48).
- Knowledge construction is done on a foundation of existing relevant mental representations – concepts, propositions, mental schemas, images, frames of reference, links and language. *From the known to the unknown.*
- The awareness threshold of learners must be acceded and attention retained. Awareness depends on:
  - the intensity, duration, magnitude, distance and complexity of the stimulus;
  - subjective involvement of the person in what is perceived – predisposition (particularly important in classroom situations). The prime determinant of predisposition is prior (internalised) knowledge, which is essential for association and assimilation. Stimuli should not compete with the thoughts of the learner. It should complement the mindset – the mind should be prepared and receptive to the new information;
  - stimuli offered should not "compete" with distracting input, e.g. educator (unconscious) disruptive behaviour, outside noise (Jordaan and Jordaan, 2000:289). Learners may be more involved with distracting stimuli considering the physiological attribute that movement catches attention and psychological attributes, variation and attention.
- New knowledge must be significant to the learners. Basic criteria for significance are:
  - The relevance of new information in terms of existing mental representations
  - The purpose of the new information – the purpose it has to the learner

- Complete, organised, meaningful and simple (as simple as possible) information
- Information fascinating to the perceiver
- Information challenging to the perceiver

- Humans have limited information-processing capacity – STM capacity (cf: Gestalt theory/STM/Monitoring).
- People tend to mentally complete a perception – add missing information – of an incomplete image (Gestalt Laws).
- People tend to group similar items together to form a gestalt (structured whole) (Gestalt Laws).
- People tend to see things that are close together as belonging together (Gestalt Laws).
- People tend to see bits and pieces that resemble mirror images of each other as symmetrical structures (pairs of) rather than groups of similar items (Gestalt Laws).
- People tend to perceive interrupted patterns as the simplest, most orderly, symmetric, and regular figures they could represent – mentally completing interrupted patterns (Gestalt Laws).
- People tend to see elements moving in the same direction as a collective or unit (Gestalt Laws) (cf. 4.2.2).

These principles are complemented by educational premises also derived from the fundamental theory. Educational premises are determinants in learning opportunity planning, presentation approach and strategy that include projects, practica, methods and techniques. They represent the educational viewpoint that enhances perspective on prospective education. Being valuable guidelines, careful consideration of these premises and implementation of the knowledge accordingly, will enhance learning opportunity planning, presentation and outcomes.

The theory of learning contains fundamental attributes to learning opportunity development also represented in the following educational premises. Premises, derived from the fundamental learning theory, should be acknowledged and feature in learning opportunities. They are statements to consider in planning effective learning. The following premises, in addition to the principles, should enhance facilitation and learning:

- Constructing a proper educational foundation for effective learning is of paramount importance to unsuccessful school leavers – language, maths, science.
- Learners must be ready to learn. Mentally prepared learners are motivated, curious and anticipating. Anticipation is a mental disequilibrium that learners would be eager to equalise.
- Learners must be informed in advance about the practicum, project and learning content.
- Learners differ in terms of mental capacity, physical ability, aptitude and educational

foundation (e.g. a result of preceding education) – accommodate learner differences.

- Scaffolding is an essential part of facilitation (support is gradually withdrawn) (Woolfolk, 2010:316).
- Learning "is situated and influenced by various features of contexts" (De Corte and Weinert, 1996:275).
- Challenging learning content and practica evoke interest – presume exiting experiences.
- Exercise and repetition develops procedural knowledge into automated (unconscious) perceptual-motor skills.
- Learning can exceed the confines of gradual construction of knowledge in instances of insightful learning.

Within these guidelines educators can design learning opportunities, which are focused on effective learning and development of the learners. Compiling a list of education premises for learning opportunity design and execution is an essential orientation process contributing to perspective on education – a kind of mind preparation for educators (Appendix M).

6.3.4.4 Methodology compliant with the fundamental theory

The basic methodology for this curriculum is founded on the fundamental theory, embedded in transdisciplinary integrated education and practicum-based presentation strategy. Application is through practicum-based learning opportunities utilising projects in the practica to initiate and generate opportunities for acquisition of integrated declarative and procedural knowledge. The quest for knowledge resides in the practicum. Developing the practicum necessitates learner acquisition of integrated knowledge – perceptual-motor and cognitive development. Focussing on procedure rather than the project and knowledge construction through the procedures, distinguish unsuccessful school leavers education as practicum-based.

Learners achieve competence through active execution of the procedures and should be able to demonstrate competence through correctly repeating the procedures (cf. 6.3.3.2). Learning through the experiences encountered in the practica focuses on the calculated execution of procedures for accomplishment of the outcomes. How the integrated knowledge was constructed will reflect in the demonstration of competences accomplished signifying the importance of correctly applied methods and techniques in the practicum.

Projects are prescribed in the unit standards with due consideration of the underlying educational approach. Practica are constructed on the features of these projects (Appendix K). The projects must be significant to the learners, but cannot be selected randomly because they are predetermined in the unit standards. Practica can, however, be constructed to enhance significance and achieve specific objectives.

Sequence, relations and linking of the practica are essential to develop and represent a meaningful whole. The composition of educational parts must be significant and in perfect relation and harmony with one another for learning to be meaningful and effective (Appendix K). Selection of learning opportunity strategies, pivotal in the practicum, must be done according to these criteria. Learners should be informed about the purpose, relevance and advantages of the projects, referring to active involvement and receptiveness.

Projects are based on servicing or repairing components, constructing objects or execution of tasks related to, or in preparation for more composite exercises. Development of practica depends on the outcomes stipulated in the relevant unit standard and the attributes of the relevant project. Careful evaluation of practica is essential because they are the origin of opportunities for effective declarative and procedural knowledge construction. Identifying these opportunities empowers educators with knowledge, which they can exploit to the benefit of the learners (Appendix K).

Although procedural knowledge is more difficult to define, identifying relevant declarative knowledge required for practica is a comprehensive enterprise (cf. 4.2.3.3). Beyond function, construction, operation and procedures of projects, into the fields of language, mathematics, science and mechanics, locating learning content (information) becomes difficult and complex. A sound foundation of knowledge of the project and the subfield(s) is essential for optimal utilisation of potential. It is therefore recommended that teams of educators be assigned this responsibility. Unsuccessful school leavers' education should be a team effort, facilitated by teams of educators.

Real integration of declarative and procedural knowledge is accomplished when the practicum initiates with basic declarative knowledge (procedure) progressing to perceptual-motor activities continuously involving relevant declarative knowledge (cf. 4.2.3). Execution of the procedures requires declarative and procedural knowledge in perceptual-motor learning, leading to a need for more declarative knowledge resulting in further perceptual-motor learning (construction of procedural knowledge) – a recurring process developing progressively into accomplishment of the full procedure and appropriate declarative knowledge (cf. 6.3.3.2; 6.3.4.1). The key notion is that the quest for knowledge originates in the practicum. The whole procedure is based on a sound foundation of existing relevant declarative and procedural knowledge (existing mental representations).

Assigning significance to key concepts will enable learners to construct a skeleton of the learning content requirements. Adding "flesh" to the skeleton (reference frame) will enhance recollection, identification, association, "incubation" (internalisation) and reconstruction of the knowledge. It is recommended that educators only initiate the process, do scaffolding and assist learners in the construction (cf. 4.2.2).

Information must be presented in simplest forms possible. Gradual increase in complexity may follow up to satiation of capacity. "Everything should be made as simple as possible, but not simpler" (Einstein, cited in Reader's Digest, October 1977).

Careful guidance and facilitation is required. Special attention should be paid to the need for declarative knowledge, which can easily be skipped resulting in inadequate learning and poor integration of declarative and procedural knowledge. Gradual acquisition of integrated knowledge culminates in accomplishment of the selected outcomes. Relevant information covers the spectrum of skills, language, mathematics, (physical) science, mechanics and any other subject that can satisfy a need for information (Appendix K).

Development of knowledge beyond the required competences is allowed. Curiosity and need may necessitate development in any field of knowledge, exceeding the qualification requirements of the unit standards. Further development is beneficial to the learners in their effort to accomplish their educational aims. Higher levels of development promote their prospects in further education, e.g. learnerships, apprenticeships, NC(V) (Appendix J).

There is no ceiling for the development of the learners. The national outcomes make provision for "beyond the boundaries of this curriculum" development. Additional time spent on further development by some learners will be balanced by the slower pace of others. These features of unsuccessful school leavers' education render learner-group management a crucial aspect.

Differentiated development is possible by implementing Bloom's adapted revised taxonomy of learning. Some learners may accomplish the basics of practica while others achieve higher levels of development. Level assessment criteria, derived from the version of Bloom's revised taxonomy adapted for this study, provide a scale for evaluation of learners' achievement of competences. An abridged version of the adapted taxonomy is given for the sake of the argument. The unabridged version, which constitutes the level assessment criteria, is established in section 4.3.1:

- **1. Remembering** refers to the ability to reproduce learned content/information, replicate perceptual-motor activities and imitate behaviour.
- **2. Understanding** refers to "reproduced" content and recognition of relevance beyond the

original situation.

- **3. Applying** refers to applying sequences of actions in procedures to situations, assignments, tasks or projects and the implementation of knowledge in conduct.
- **4. Analysing** refers to dismantling learning content into elements, determining relationships, recognition of structure(s) and determines principles and function(s).
- **5. Synthesising** refers to composition of new ideas/procedures, acquisition of new mental assets and innovation.
- **6. Evaluating** refers to making judgements: thorough knowledge of the topic and motivated appropriate judgements and selections.

Provision must be made for differentiation in each outcome according to these criteria. Learner differences are taken into account by divergent expansion of knowledge, originated in the practica, until satisfaction or a ceiling of ability is reached. Motivating tools for accomplishment of higher levels are prospects of further education, e.g. learnerships, apprenticeships and NC(V), entry requirements of further education, occupational prospects and curiosity. Time spent in higher-level cognitive development by some learners should simultaneously be spent by lower level learners for mastering the declarative and procedural knowledge in acquiring competence and confidence. Learner differences, signifying different levels of accomplishment, should virtually equalise their time schedules. Incorporating this crucial aspect in learning opportunity design, can benefit all learners through the spectrum of abilities.

6.3.5 LEARNING OPPORTUNITY DESIGN

Learning opportunities are the occasions where learners are exposed to the projects and associated learning material to engage in processes of constructing their own mental representations (knowledge), facilitated by educators (cf. 3.4.6). Educators present the declarative and procedural information to the learners utilising strategies, appropriate to practicum-based education that can facilitate learning.

Methods, techniques, options, venue, equipment, tools and media constitute the "science", "battleground" and "hardware" of the strategy. Composing these into a feasible pleasant and constructive learning opportunity and conducting it, is an art – the procedural knowledge of an educator (Feldman and McPhee, 2008:7).

Learning opportunities are the occasions where learners are exposed to the learning material and encouraged to observe, investigate, consider, exploit and construct knowledge, facilitated by the educator. Introducing the information, from which the learners must construct their own versions of knowledge, takes place during the course of the practicum. Each learning opportunity must include repetition of the practicum procedures by the learners to facilitate learning and immediately putting the constructed knowledge to the test. Learners must learn how to construct knowledge in applications with simultaneous acquisition of declarative and procedural knowledge – knowledge and perceptual-motor skill.

Learning opportunities should be designed with the focus on the execution of the practicum with essentially embedded declarative and procedural knowledge. Several opportunities may be necessary for completion of a task or unit, making learning opportunity arrangement a logical step in the process. Each learning opportunity should cover one or more unit standard outcomes depending on the rate of progress, which is restricted by limited STM capacity of the learners – the bottleneck. Assessment must be a continuous process as integral part of the education contributing directly to learner development.

Presentation strategies are comprehensive plans of ***facilitating*** and ***managing*** the course of events in learning opportunities through implementation of methods and techniques and discreet application of tactics. Methods and techniques are selected to facilitate the activities and complement the learning material for effective learning – *integrated acquisition of declarative and procedural knowledge*.

Utilising the information from the curriculum and unit standards, the educator can develop learning/discovery opportunities using a framework similar to the curriculum design cycle. This arrangement is recommended to ensure comprehensive, coherent and consistent learning opportunities.

6.3.5.1 Learning opportunity design cycle

The learning opportunity design cycle correlates with that of the curriculum comprising *situation analyses, *interpretation of outcomes, *learning content, *learning theory and strategy, *assessment of learning, *venue preparation *opportunity benchmarking, *presentation (teaching) strategies (cf. 3.4.1).

Learning opportunities are constructed on a basic framework of mind preparation, relevant internalised knowledge, integrated declarative and procedural knowledge construction, transdisciplinary knowledge expansion, assessment and accumulation of units (credits). On this basic structure learning opportunities for effective learning can be built.

6.3.5.1.1 Learning opportunity situation analyses

The situation analysis, being the investigation into the practicability of learning opportunities, comprises evaluation of all the contributing elements. The first considerations in developing learning opportunities will be: "What is the knowledge foundation (existing mental representation) of the learners?"; "How do learners learn best?" and "Which learning experiences will the learners need to reach the learning opportunity goal?"[8] (Krüger and Müller, 1990:25). How learners learn best is discussed in 4.3.2.

The considerations essential to the evaluation and selection processes include all the people and factors that will be involved in the learning opportunity: learners, educator(s), facilities, equipment, projects and documentation. Finding common ground for the learner majority, something they can associate with, is an integral part of the enterprise. Common ground establishment for unsuccessful school leavers' education is simplified by the practical (hands-on) base of the educational approach. Practica spanning more than one learning opportunity should be divided, retaining logical sequence and coherence, into significant divisions representing interrelated parts of a holistic exercise. The framework for a learning opportunity situation analysis contains essentials for the mini-investigation that should be done for every learning opportunity design (Appendix M).

A comprehensive checklist will facilitate and enhance the situation analysis, saving time and effort. Educators should develop a standard working procedure in learning opportunity analysis, design and development. A learning opportunity skeleton, like the example in Appendix M, can assist in drafting a framework and presentation pro forma for learning opportunities. Educators can draft their own skeleton for learning opportunity planning and development. Once a presentation (teaching) style has been established, adaptations or restructuring to suit personal preferences can be made.

Educators need to determine the attributes of the knowledge foundation (frame of reference) required for new information and compare it with the internalised (prior) knowledge of learners. Carl (2010:66) emphasises the importance of the educational level of the learners, which is equally applicable to learning opportunities: "One of the most basic points of departure is that any curriculum must take account of the development level of the child." Determining learners' knowledge foundations (internalised knowledge/existing mental representations) is essential for the procedure to accomplish effective learning. Once learners have built their knowledge structures in the course, assessment results will be a measure of

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[8] Translated from the Afrikaans.

their knowledge foundation. This comparison will enable educators to select relevant learning content, linked to the knowledge foundations of all learners, to construct a continuing chain of knowledge. An appropriate arrangement of learning content and opportunities will facilitate a process of gradual construction of knowledge on a foundation of relevant knowledge.

Arrangement of the learning and discovery opportunities has to contribute to a meaningful, logically assembled whole. The final "picture" should not be vague or distorted but clear in competence required and value. Learning and discovery opportunities must be arranged according to the most suitable structure to build the final product.

Taking account of learner differences means determining the context and content of the knowledge foundation required for the construction of the new knowledge and mind preparation that would include all learners. Building learners' relevant knowledge foundation, if it does not exist and creation of curiosity and anticipation are compulsory for effective and pleasant learning experiences.

What the learners bring to the learning opportunity is of paramount importance. They bring intellectual capacity, aptitude, knowledge, skills, beliefs, culture, personality and attitude to the event. Unsuccessful school leavers bring poor educational background, lack of language, mathematics and science proficiency and learning barriers to learning opportunities. Accommodating unsuccessful school leavers, who want to improve skills and qualifications in further education, will involve a number of considerations for educators:

- Acknowledge that they differ in terms of attributes, mental and physical ability, aptitude, frames of knowledge, experiences and beliefs.
- Acknowledge that they could not succeed in school and NC(V) programmes with the educational approaches adopted by schools and FET colleges.
- Expect them to dislike "learning the traditional" way.
- Expect them to be poorly motivated for learning due to previous lack of achievement.
- Expect learners to have an inability to transfer knowledge from subjects or prior courses to the projects/problems at hand (Jakobsen and Bucciarelli, 2007:297).
- Learners, once exposed to constructivist education, prefer this educational approach (Kim, 2005:11).
- Learners' learning performance improves with a constructivist educational approach (Kim, 2005:12).
- Unsuccessful school leavers who enrol in engineering studies at FET colleges have the desire to improve their socioeconomic situation. They will therefore be receptive to further education significant to them that can improve their knowledge, skills and qualifications.

- Avoid rigid expectations based on first impressions, prior school or college results.
- 70% of learning can be attributed to doing (Meier, 2000:91).

Taking these factors into consideration in learning opportunity planning will improve learning and make these sessions pleasant experiences for learners and educators alike.

The other human factor in education is the educator. College respondents who participated in the research are well-educated, well-informed, concerned and dedicated personnel. In the educational scenario the educator must evaluate himself against the criteria provided by the authorities. These attributes and virtues will inevitably reflect on learning opportunities. The educator brings knowledge, skills, values, experience and personality to the learning opportunities. Each of these attributes deserves continuous attention.

The rate of progress is astronomical and educators must keep up with knowledge and technological development, which means continuous updating of knowledge and skills – life-long learning. Educators should also acknowledge that their knowledge and skills – declarative and procedural knowledge – are ***their constructs and versions of reality*** (truth). Benchmarking them against primary sources (continuous study) will keep their attributes close to reality, thus rendering them more competent.

Facilities, equipment and learning material will be provided by FET colleges (or relevant educational institutions). The choice of facility or venue will be determined by the practicum. It must meet the requirements of the learner group, the equipment, project and the activities involved.

Execution of the activities of a practicum requires instruments, tools and equipment. These should be available because substitutions will bring about changes in concepts, theories, knowledge and skills. Listing the selected items will facilitate acquisition of the underlying theories, safety measures and procedures. In practicum-based education all the elements (project, equipment, tools and media) involved contribute to the collection of information available to the learners. This diversity facilitates extension of information into various fields and subfields ((college) subjects), covering the learning content identified in the curriculum outcomes as revealed in the research.

Documentation required comprises unit standard, study/project guide, OHS regulations, workshop/procedure manuals and assessment instruments. Literature requirements will include notes and textbooks. Support material can elucidate the presentation and enhance learning. Support materials include sketches, posters, transparencies, films and DVDs but are not limited to these items. Innovative educators can develop attractive, appealing, practicable and effective learning opportunities.

The results of the situation analysis should provide answers to the basic questions, guiding the procedures of the learning opportunities.

6.3.5.1.2 Learning opportunity interpretation of outcomes

A learning opportunity must be built on one or a limited selection of a unit standard's outcomes – national, curriculum, and unit standard. Differentiating the unit standard outcomes into knowledge, skills and values representing declarative and procedural knowledge will create an information base for the learning opportunity.

Outcomes are the prime guidelines for learning opportunity design. They prescribe the competences learners need to demonstrate for acknowledgement of achievements. Analysing them and differentiating the competences into knowledge, skills and values will enhance selection of learning content and practicum construction. Educators and learners should know what is expected. These analyses should be included in the study guides, which should be available to learners. From these elaborations expected competences in terms of knowledge, skills and values (declarative and procedural knowledge) are derived. Breaking down the competences into detail enhances comprehension, perspective and evaluation.

These elaborations on outcomes differentiate into contributions to content, premises, teaching strategies appropriate to the kind of practicum, venue preparation, assessment of learning and opportunity benchmarking. They provide the detail of the achievements to be accomplished in every learning opportunity.

The unit standard outcomes, incorporated in learning opportunities, should be accomplished, but only relevant national and curriculum outcomes need to be pursued – those documented in the unit standards.

6.3.5.1.3 Learning opportunity learning content

Learning opportunities need to cover the requirements of outcomes constituting the knowledge, skills and values (declarative and procedural knowledge) incorporated in the practicum. Considering the content necessitates outcomes analysis to identify the content required to embody the declarative and procedural knowledge potentially enabling achievement of the competences represented in the outcomes (Wong, 2006:954).

Learning material and the planned experiences are selected to facilitate the practica and enable acquisition of the outcomes specified in the unit standards. Identifying and listing requirements enhance selection of learning material and activities that can provide the information needed in the learning process – learning material additional to the project.

The competences expected are of prime concern and should be achievable with the learning content (information and activities) contained in the practica. Educators have the privilege to identify the content and exploit the full potential of practica. Expanding the information base beyond the confines of practica while retaining relevance is an appealing challenge, but at higher levels relevance may fade. Learning opportunities aim at acquisition of integrated declarative and procedural knowledge – cognitive and perceptual-motor development.

To ensure immediate establishment of links with the new material the internalised pertinent knowledge (existing mental representations) must be taken into account when arranging the sequence of exposure to the new material. The internalised knowledge of the learners is essential because this is the foundation for the construction of the new knowledge. Gaps will hamper sensible learning and progress (Krüger and Müller, 1990:39-48; Carl, 2002:113).

From the fundamental learning theory, it can be concluded that significance, sequence, relations and linking of the learning content is essential. Linking refers to associating new information with internalised knowledge emphasising manageable leaps into new material, avoiding gaps. Learners must be able to connect (associate) the new material to prior (internalised) knowledge.

Learning is normally impaired by poor language proficiency. Literacy and numeracy are recognised by the authorities as the fundamental framework of the ability to learn. Language and numeracy must receive serious attention in unsuccessful school leavers' education. Special provision is made for language, mathematics, science and mechanics development in the outcomes of the unit standards.

Learning content of a learning opportunity must be reduced to a manageable volume considering the time schedule and the capacity of the learners. The pace of practicum progression should allow for the rate of knowledge processing limited by the flow of stimuli through short-term memory (STM). It will involve the information and activities identified in the analysis of the outcomes which are required to accomplish the acquisition of the expected competences in terms of knowledge, skills and values (declarative and procedural knowledge).

6.3.5.1.4 Learning opportunity learning theory and strategy

The fundamental learning theory remains the same for all learning opportunities, the strategies suggested by the outcomes and learning content. Learning is considered to be psychological processes that bring about cognitive development and improvement in psychomotor ability.

Memorised facts may have potential, but are inactive in the absence of relevance, relationships, interactions and application. The value of knowledge is primarily determined by what can be done with acquired knowledge. Knowledge improves ability if it is functional and comprehension is the first step towards application. Rote learning (memorising) is hard work, but comprehension is fun. In practica, comprehension and application produce competence, but repetition generates confidence.

6.3.5.1.5 Learning opportunity assessment of learning

Learning opportunity assessment is primarily formative assessment – assessment for learning – including continuous observation. Monitoring activities, perceptual-motor development, comprehension and progress are crucial for learners and educators providing a continuous flow of information regarding learning, enabling timely interventions to keep the processes on track and facilitate real progress. End of session tests to assess competence can accumulate towards summative assessment results and accomplishment of units.

Assessment of competences is a bi-articulated procedure, judging psychomotor ability and assessing cognitive development. Procedures followed and levels of cognitive involvement to accomplish outcomes are as important as the results. The objectives are perceptual-motor and cognitive development of the learners.

Learning opportunity assessment at the end of a session can accumulate towards evidence of competence recorded by the educator and filed in the portfolios of evidence of the learners. Units can be accomplished, recorded and contribute toward achievement of modules, divisions and eventually qualification levels. The main concern in learning opportunity assessment is, however, the extent and level of declarative and procedural knowledge achieved, measured against the outcome criteria guided by Bloom's adapted taxonomy of learning.

Well-planned and documented instruments for formative assessment and continuous observation improve validity, reliability and credibility. Tests, questions and observation rubrics should be drafted well in advanced and evaluated to ensure practicability and effectiveness. Simultaneous drafting of assessment instruments and memoranda enhances perspective on the intention and question quality. Memoranda for tests, questions and observation rubrics are compulsory because they serve as evaluation for questions and answers.

Oral questioning is an integral part of learning opportunity presentations and therefore of the planning and preparation phase. Questions and answers should be prepared in advance, but questioning cannot be limited to these questions because incidents, requiring instantaneous questions, may occur during a presentation/practicum.

Oral questions during presentations have distinct functions. They should:

- re-establish attention;
- assess comprehension;
- guide proceedings; and
- encourage and guide thoughts.

In unsuccessful school leavers' education, assessment is focused on accomplishment of competence in cognitive and psychomotor activities according to the requirements of the outcomes. Much of the competence is acquisition of procedural knowledge (skills) necessitating assessment of hands-on assignments and projects. This also applies to continuous assessment and observations during the course of practica.

Assessment instruments and observation rubrics must make provision for procedure evaluation and acquisition of competences according to the adapted Bloom's taxonomy of learning. Different levels of accomplishment should be assessed throughout the course. Documents must be reduced to the absolute essential because facilitation of practica necessitates continuous, uninterrupted attention of educators. Administrative duties should not interfere with learning opportunities.

6.3.5.1.6 Venue preparation

The creation of learning environments is a crucial aspect in the establishment of learning opportunities. This is included in the planning and preparation phase of learning and discovery opportunities. The ideal venue is an attractive, appealing and well-equipped environment stripped of distractions and irrelevant information. Learners should enter the venue for the new learning opportunity with curiosity and anticipation.

The venues of unsuccessful school leavers' learning opportunities are practilabs (venues/ workshops/laboratories for practical exercises in education). A practilab can be a classroom or any venue equipped and arranged for practica. The concept of *skills training* reduces connotation of the process to motor activities. Unsuccessful school leavers' education involves acquisition of declarative and procedural knowledge simultaneously, i.e. integrated knowledge acquisition and perceptual-motor development without conscious crossing of "boundaries". These features can be achieved in well-designed and executed learning opportunities.

Venue preparation must be done **well in advance.** Preparation done at the beginning of the scheduled period demonstrates a lack of professionalism. Venue preparation involves the following aspects:

Criteria

- Subject knowledge, skills and values notes to be readily available for the presentation
- Component/project to be studied
- The hardware – components, equipment, tools, documents (papers), support material (media, appliances)
- Location of hardware and support material – floor plan/layout
- Blackboard/whiteboard plan – information layout
- Learning environment – setting up an attractive, interesting and enticing environment
- Evaluate the setup – can the outcomes be achieved? Do they comply with the requirements of the adopted teaching strategy?
- Recording of shortcomings and recognized improvements to be considered

Well-prepared venues contribute towards an atmosphere conducive to effective learning, smooth procedures, minimum distractions and interruptions.

Venue preparation comprises the facility, project, equipment, tools, teaching media and accommodation of the learners. A well-planned practicable layout will facilitate presentation of the practicum. Movement of learners during practicum activities should not disrupt the flow of events. A floor plan of the venue can enhance planning and contribute towards smooth progress of the activities. It can furthermore serve as a reference for improvement in future sessions.

A black/white board layout of that specific part of the learning content will portray the message of a well-organised presentation. It will obviate inappropriate utilisation of space and eventual disorder.

Learners should know in advance what their responsibilities will be during the practicum. If they know what is expected of them they will do some "mind preparation" themselves. Success of practica and learning opportunities can be improved by benchmarking the events against preset criteria.

6.3.5.1.7 Learning opportunity benchmarking

Learning opportunity benchmarking is compulsory for unsuccessful school leavers' education because learning opportunities and practica signify a battle against ignorance and incompetence. In the process, inadequacies should be identified and corrected in an effort to ensure effective learning. No learning opportunity can be perfect, so striving towards perfection should be the predisposition.

Every learning opportunity should result in effective learning and the acquisition of integrated declarative and procedural knowledge. Accomplishment of that aim necessitates effective learning opportunities. Effectiveness of learning opportunities cannot be judged on results alone. How the results are accomplished is of paramount importance and affords opportunity for improvement. Further justification of learning opportunity benchmarking is professional support for educators, development and improvement of education at the institution.

Support from peers and management is indispensable. Honest evaluation of learning opportunities, assisted by colleagues and management, is an essential procedure in the personal development of educators (Van der Horst and McDonald, 1997:119). Killen (2010:109) states that "[N]o matter how well you teach, there is always room for improvement."

Evaluation of learning opportunities must be done on different levels. On a personal level, it must be done continuously and at every learning opportunity. Discussing personal benchmarking in private with a colleague or senior can provide perspective and opportunities of improvement. This underscores the need for further educational study, subject or field study and/or updating of workplace knowledge and skills. Dedicated life-long learning is contained in the essence and nature of the profession.

Every aspect of each learning opportunity must be scrutinised against a set of criteria, preferably in a rubric. The results should identify weaknesses, shortcomings, adequacy, strong points and excellence. Rating every aspect according to this scale identifies areas for improvement and inspires educators to develop their educational capacity, i.e. their declarative and procedural knowledge. Strong points and areas of excellence can be recommended and serve as motivation for improvement to other educators without regarding excellence as ultimate or permanent.

Results of official benchmarking must also be discussed in group context: at programme level and at committee/subject committee level. Problems can be thrashed out and excellence shared. Reflecting on the course of events in learning opportunities during discussions can highlight the strengths and weaknesses in a quest for evaluation and perspective. Equipped with this knowledge, educators can work towards improvement of the learning opportunities and presentations.

Rubrics, specifying the criteria for learning opportunity success, are necessary for objective evaluation of the course of events and the outcomes achieved. Heads of faculty, monitoring and supporting the educational process, must use equivalent assessment instruments. Educators must design and develop comprehensive instruments (rubrics, scales or evaluations) to identify weaknesses and strengths for appropriate measures signifying improvement. The rate of development in education and technology necessitates continuous study in educational methods and field of specialisation. Personnel performance assessments must be confirmed by classroom performance documentation.

The assessment tool for benchmarking learning opportunities should involve the roles, duties and influences of all the involved and responsible entities: educators, management, facilities, equipment, teaching media and learners. Individual differences will reflect in the respective learning opportunity assessment tools. Learning opportunity benchmarking is exemplified in Appendix N.

A much more detailed framework is necessary to cover the most important aspects under each heading. Elaboration on each point in collaboration with management is essential. Expanding each concept into subdivisions of detail and criteria, complementing national and college policies, can constitute credible, reliable and valid instruments. Without management's consent learning opportunity benchmarking will have limited and only personal value. The final assessment tool (rubric) is a matter of personal preference presumably with management consent.

Involvement of management (faculty head and/or programme manager) is primarily aimed at educator support. They are the personnel with the experience and knowledge to help educators dealing with particular situations, and to assist in improving their proficiency. Management of the institution will most probably have their own assessment (benchmarking) criteria. They should focus on educator development, facilitation and learning opportunity management improvement.

Learning opportunity benchmarking is not only about educator proficiency, but should reflect on facilities, equipment, learning aids and student involvement and behaviour. This is an essential but comprehensive task involving virtually the entire hierarchy of an institution. Each level of the personnel hierarchy will eventually have an assessment instrument specifically designed for that level. Learning opportunity benchmarking is an integral part of education and educational development. Learners have the right to effective education.

First time learning opportunity design and development could be a daunting task, but once completed repetition and improvements would be less of an effort and even encouraging when the positive results are experienced.

6.3.5.2 Learning opportunity teaching strategies

Teaching strategies are plans for the modus operandi necessary to facilitate construction of declarative and procedural knowledge form the learning content (information) provided. Strategies comprise all of the activities, methods, techniques and tactics educators envisage bringing about effective learning – construction of declarative and procedural knowledge required for cognitive and perceptual-motor development. Strategies for unsuccessful school leavers' education need projects, equipment, tools and educational media for the execution of transdisciplinary practica in learning opportunities.

Psychomotor capacity necessary for mechanical skills development involves perceptual-motor learning resulting in another facet of knowledge, procedural knowledge. This is the ability (know-how) to mobilise knowledge into motor action (bodily movements) in a wide variety of situations. Slightly different strategies are required in these types of learning opportunity, contributing to their integrated nature (Woolfolk, 2010:259). The attributes of psychomotor capacity add significant qualities to the learning process and development of learners.

Teaching changes learning, teaching preferences and practices. Teaching is also learning and development for the practitioner. Teaching style is a blend of personal attributes and learned teaching capacity (declarative and procedural knowledge). What the candidate brings to teacher training – personality, knowledge, skills and values – as well as the course content and how it is perceived, will determine the teaching style. Although lecturers lead by example, candidates' responses to that are the determinants of their own abilities.

The identified teaching styles are virtually didactic derivatives with little significance as separate attributes that educators bring to the classroom. Teaching strategy, methods, techniques and dynamic presentation should be the (main) focus of educators.

Educators should realise the value of their presentation to learning and how it suits learners and content. They should also acknowledge what learners bring to the learning opportunity – aptitude, background/prior knowledge, skills and interests (Reiner and Willlingham, 2010:35). What learners think about during the presentation is more important than a "right" teaching mode matching their learning preferences.

How unsuccessful school leavers can be guided in the process of developing learning attitude, commitment, dedication, determination, persistence and deliberate calculated execution should be established as prerequisite to any educational attempt. Special information, habits, interests, attitudes and ideals, which they demonstrably produce, can be exploited for learning opportunity planning. Progressively building the knowledge structures of learners will narrow the "gaps" between individuals and facilitates detection of prior knowledge (knowledge foundations for construction of new knowledge).

The fundamental theory of constructivist learning can be described as follows:

- Learning is a personal psychological process of constructing knowledge on existing relevant mental structures of concepts, images, mental scripts/schemas and frames of reference.

By implication this means that in the absence of an existing relevant mental structure (knowledge foundation) ***effective*** learning is not possible. Educators are therefore obliged to determine the existence or absence of relevant prior knowledge and to facilitate building appropriate mental constructs as foundation for the new learning content they intent to present. It can further be concluded that extensive existing mental constructs make learners more receptive to a wider variety and greater quantity of new information, providing a greater mental foundation.

Prior knowledge is the foundation for the construction of new knowledge. "Teachers should learn in detail what the students know about the subjects matter" (Ouellette, 2000:1 of 7). In general, assessing what learners bring to the learning opportunity will enhance the framework of presentation (learning opportunity) preparation. In learning opportunity design, educators should contrive methods and techniques complementing psychological learning theories considering the learning content.

The structure of relevant internalised knowledge, frames of reference and links should have been constructed in previous learning. Gradually building a structure of relevant existing mental representations – concepts, models, patterns, schemas, images and frames of reference – for future unconscious referencing will substantially improve mental manipulation and accomplishment of declarative and procedural knowledge.

Interaction amongst learners is a technique to enhance learning by evaluation of each other's interpretation of the content and schemata (intersubjectivity). Improving reflection on their own constructs will stimulate learners' thoughts and comprehension (Von Glasersfeld, 1982:1). Knowledge is regarded as information based on intersubjectivity and viability processed into mental constructs by individuals. The two main types of knowledge, declarative and procedural, are of concern. They constitute the OBE notion of knowledge, skills and values. New knowledge must be introduced in an enticing manner and links with prior knowledge initiated. The theory of constructivist learning necessitates "foundation construction" and mind preparation.

Mind preparation is an essential process preceding effective presentation and extending from the conclusion of the previous learning opportunity into the introduction of the next occasion. The two main features of mind preparation are first, linking the new knowledge with existing internalised knowledge (existing mental representations) and second, a stimulating introduction of new knowledge, creating curiosity. Learners must look forward to the occasion in anticipation of exciting things to happen. Their readiness to learn is primarily the acknowledgement of insufficient own (learner) knowledge to deal with a problem or situation, which is challenging enough to justify action (Von Glasersfeld, 1997:8).

Learners not mentally excited and ready or those with a lack of curiosity and anticipation will experience difficulty participating and keeping up. Together with assessing learners' knowledge foundation, creating curiosity and anticipation constitute mind preparation. A prepared mind is more receptive to new information.

Thorndike's "law" of readiness did not withstand scientific scrutiny, but educators can fruitfully incorporate some version in their learning opportunity premises because it emphasises mind preparation (Lefrançois, 2000:69; Hergenhahn and Olson, 2005:60):

- When a learner is ready to learn, learning is satisfying.
- When a learner is ready to learn and learning does not take place, it is annoying.
- When a learner is not ready to learn and is forced to do so, it is annoying.

Louis Pasteur (1822–1895) commented: "In the fields of observation, chance favours the prepared mind." This is particularly relevant to the proposed curriculum for unsuccessful school leavers (Barnett, 2011:1 of 1).

Mind preparation is compulsory in unsuccessful school leavers' education. *Prepared minds are more receptive.* Mind preparation encompasses assessment of existing relevant mental constructs as well as building on the existing foundations of relevant knowledge. The second facet of mind preparation is creation of curiosity and anticipation. Assuming the existence of relevant mental constructs may lead to apparent poor learning and learning opportunity failure.

Logical sequencing of proceedings contributes towards coherence and continuity. Establishing relevance, links and frame of reference is enhanced by sequencing according to succession, progression, procedure and association. A sound sequence is conducive to steady progress, while deviation may cause confusion, distraction and misconception, which in turn will be time consuming and inefficient.

Rate of progress should be meticulously thought through, assessed and adapted to match the abilities of the learners to keep up with the pace. It must be borne in mind that people have a limited rate of knowledge processing, and that processing and flow of stimuli through STM limits the rate at which new knowledge can be constructed.

Teaching strategies involve more than just methods and techniques. Continuous adaptations to the flow of events, interventions, withdrawal, corrections and strategic questioning are tactics, when discreetly applied, denoting a teaching skill. The essence of using tactics is meticulous monitoring of the process or situation and timing of the actions. Formative assessment and continuous observation keep learners and educators informed about their situations, enabling timely interventions.

Compiling learning opportunity premises is good mind preparation for educators. The process of compiling such premises focuses the mind on significant features of the learning and presentation processes. A comprehensive list is given in Appendix M, from which significant relevant premises can be selected.

6.3.5.3 Accommodating learner differences in learning opportunities

Learners have different mental and physical capacities and also differ in aptitude, interests, educational background and learning barriers. These differences must be considered in unsuccessful school leavers' education to establish a sound foundation for development in the fundamentals of learning and skills development. Killen (2010:31) emphasises the uniqueness of each learner and appreciation of different capacities and the contributions individuals can make to learning opportunities. This accentuates involvement of all learners in learning opportunities with the prospect of discovering significant contributions or potential contributions by them.

Learning style theories and the theory of "multiple intelligences" do not meet the requirements of scientific standard and they are not educationally significant in dealing with learners' differences. Acknowledging learner differences, context (learning is situated), building on prior knowledge and mind preparation are regarded superior to these theories. These scientifically unfounded theories are regarded as inappropriate and superfluous (cf. 4.3.2).

Learner differences are accommodated in practica in the diverging progress and expansion of learning content (information) and experiences (perceptual-motor development). Faster accomplishment of competence provide opportunities for delving deeper into fields of interest and simultaneously buy time for slower learners to accomplish the desired competences. Managing this kind of differentiation in learning opportunities requires appropriate planning and preparation. Woolfolk (2010:272) suggests diversity in learning strategies that can be employed in unsuccessful school leavers' learning opportunities to involve all the learners and promote effective learning – declarative and procedural knowledge construction.

The structure of practicum-based education (learning-by-doing) affords development through various levels of proficiency, from the basic successful execution of a task to higher levels of understanding, measurements, calculations and diagnoses. Adding the transdisciplinary approach extends opportunities further into the cognitive domain allowing development until curiosity is satisfied or a ceiling of ability has been reached. The research reveals low quality preceding education as a contributing factor in unsuccessful school leavers' poor educational achievements presuming potential beyond their demonstrated capacity.

6.3.6 ASSESSMENT OF LEARNING/COMPETENCE

The importance of accomplishment of outcomes through development of the associated competences was emphasised before, but they must be validated with recorded evidence (cf. 3.4.6.5). The evidence substantiates demonstration of these competences by the learners including the validity of procedures followed. By emphasising performance, it is evident that the procedures leading to accomplishment of competence (declarative and procedural knowledge construction) are equally important and therefore should be assessed on an equal basis as outcomes (cf. 3.4.7). Without appropriate execution of these procedures competences would be incomplete – incomprehensive end-results.

The final product, completed project or assignment, does not represent the outcome. In outcomes the demonstration of competence, actively demonstrating the procedures, constitutes the competences defined in the outcomes. A forgotten locking device in an engine cannot be detected form the outside, but it will have dire consequences later. A 90% effective assembly can be a total failure.

In unsuccessful school leavers' education with its practicum-based learning opportunities and transdisciplinary education approach, how competences were acquired is as important as the outcomes. The competences therefore include all of the procedures involved in the desired demonstrations denoting comprehensive performances. How these procedures are performed comprises methods and techniques which are often project specific, but valuable knowledge in skills (procedural knowledge) development – developing a skills foundation. A running engine or well-performing piece of equipment does not signify competence in unsuccessful school leavers' education. How that end-result was accomplished is equally important because it involves processes requiring competences that must be demonstrated. These competences should be transferable to other applications because a broad skills foundation is a prerequisite for problem solving in practica and projects.

In assessment of competences the focus shifts from the educator's performance to that of the learners without neglecting the educator's accountability (Woolfolk, 2010:316). Learning content and learning opportunities concentrate on the learning experiences of the learners and how well they perform in these activities. Moving the emphasis away from facilitation and scaffolding to the educational activities of learners in learning opportunities, designates precedence given to learning and learner development. These activities and learner development should be assessed and recorded. Evidence of learning progress and recording thereof by learners and educators are equally important. Learners' portfolios of evidence (POE) are therefore imperative in addition to educators' recording of performance and achievement.

Recording will include portfolios of evidence kept by the learners. Standards will be set for measurement of accomplishments. Assessment criteria are built into unit standards, but the instruments, method and techniques should be developed according to the unit (or practicum) and outcomes. A challenge in the assessment will be to determine whether specific features of the assignments, common to workplace procedures, have been achieved.

Learning opportunities should pursue outcomes, the outcomes should accumulate into units and units should fit into modules, modules into divisions and levels covering the whole curriculum in the process. The curriculum, unit standards and practicum procedure and assessment guides will be working documents for the educators and learners. Judging themselves against the assessment criteria, unit standard, curriculum and national outcomes will enable learners to be informed about progress and position throughout the programme.

6.3.6.1 Assessment strategies for unsuccessful school leavers' education

Assessment is a process of collecting conclusive information about the knowledge, skills and values – declarative and procedural knowledge – learners can demonstrate, and assigning value to it. To what extent it represents the true capacity of the learners, is debateable, but with thorough deliberation, careful design of the instruments and a favourable atmosphere during execution, the results can be functional. Instruments need to meet criteria and assessors and moderators must be objective, consistent and committed in this crucial facet of education. Educators need to know the capacities of their learners and must be able to objectively assess learner cognitive and perceptual-motor achievements.

6.3.6.1.1 Assessment strategy for differentiated unsuccessful school leavers' education

Assessment is done against criteria derived from the outcomes because learners are declared competent when they have accomplished the competences defined. In unsuccessful school leavers' education, with its differentiated approach, assessment is not straightforward judgement of *competent* or *not yet competent*. Competence can be achieved by just completing a project successfully or it can be achieved by demonstrating competence in higher order outcomes and reaching higher levels of cognitive development, made possible through transdisciplinary education. Just complying with the basics renders competence on the basic level of achievement.

Assessment criteria are included in the unit standards. The knowledge, skills and values learners are supposed to achieve are extracted from the relevant outcomes constituting the skeleton of the unit standards (Garrison and Ehringhaus, 2007).

Summative assessments in learning opportunities are primarily focused on judgement. The results can accumulate in contribution to the final programme score or can assist in the decision to progress to new material or a new module in the programme. Bloom's taxonomy of cognitive development is valuable guideline in distinguishing the level of development of learners. The outcomes will be guiding factors in the selection of type and format of the instrument (Van der Horst and McDonald, 1997:172).

Learning is differentiated into psychomotor capacity and Level Assessment Criteria (LAC 1, 2, 3, 4, 5 or 6) derived from Bloom's revised taxonomy, distinguishing between the different levels of accomplishment of a specific curriculum level. The following summary of levels, derived from Bloom's taxonomy of learning outcomes, is labelled to enhance classification of competences:

LAC 1: Remembering refers to the ability to reproduce.

LAC 2: Understanding refers to construction of meaning and the ability of mental manipulation.

LAC 3: Applying refers to carrying out procedures and application of theories and rules.

LAC 4: Analysing refers to dismantling content into elements, determining relationships, recognition of structure(s) and determining principles and function(s).

LAC 5: Synthesising refers to assembling elements into new patterns, structures, systems or ideas.

LAC 6: Evaluating refers to making judgements for approval of concepts, theories, procedures, methods and techniques.

These LAC evaluations apply to all the curriculum levels distinguishing the cognitive level of accomplishment. According to the LAC levels, qualifications can be issued meeting the criteria for specific further development or occupations, e.g. Mechanical Skills 2, LAC 3 refers to potential in further education in learnerships or apprenticeships; Mechanical Skills 2, LAC 4 or higher refers to potential in further education like NC(V) 2.

The purpose of assessment in unsuccessful school leavers' education includes the function of determining the proficiency of learners for further development. What the learners can do with the acquired knowledge – reproduce, explain, apply, solve problems, transfer and/or assess – is of paramount importance for further development. They have four distinct options: further education in NC(V)[1], learnerships/apprenticeships[2], lower level skills[3] or micro entrepreneurships[4] each with specific requirements. Learners have the freedom of choice, but they need to qualify for their selected option. Enrolling learners in courses with which they do not have the ability to cope is not a privilege to them but rather a punishment.

For further clarification LAC levels can be differentiated into psychomotor capacity and LAC 1 cognitive development, psychomotor capacity and LAC 2 cognitive development and psychomotor capacity and LAC 3 or higher cognitive development on a specific curriculum level according to the learner aims pursued. Further development can be pursued according to the following examples:

- skills development = LAC 1
- lower level skills occupations = LAC 2
- bridging into further education = LAC 3, 4 or higher, depending on the type of further education, e.g. apprenticeship, learnership or NC(V)

Successful completion of a curriculum level according to these criteria renders learners competent to progress to the next applicable level. Improving prospects can be accomplished with higher levels of development. These criteria complicate assessment of competence in unsuccessful school leavers' education, but their educational situation necessitates differentiation to enable accommodation of learner diversity.

Provision must be made in the assessment instruments to accommodate the mentioned LAC (criteria) in each competence assessment. Learners can primarily be competent in basic declarative knowledge (reproduction) and procedural knowledge (skills) LAC 1, integrated declarative and procedural knowledge on cognitive level LAC 2 or integrated declarative and procedural knowledge on cognitive level LAC 3 or higher. Meticulously designed assessments must include utensils differentiating the competences according to level assessment criteria (LAC).

Practica in transdisciplinary education make this differentiation possible because some learners can "do the job", others are capable of calculated execution of assignments and transfer the competences to other situations, while others are capable of involving more cognitive capacity in their performances venturing into diagnostics, critical thinking and problem solving. Although oversimplified, this notion is the attribute of differentiation of accomplishments.

Grouping learners according to these criteria and level of achievement (or own choice), can simplify assessment tools and drafting according to the aims of the group. Learners achieving these qualifications should be competent and confident to perform on the designated level of accomplishment.

The learners' portfolios of evidence are more important than educators' work reports. Compiling a portfolio of evidence is an integral part of the development of the learners: this is an additional skill that they have to accomplish. An educator's work report only confirms that the recorded work has been dealt with. The portfolios of evidence of the learners should confirm progress, achievements and competence. Educators must frequently attend to the portfolios of evidence and the information transferred to the learner's records.

6.3.6.2 Assessment criteria

Educators are concerned about achievement of the knowledge, skills and values denoting the competences represented in the outcomes. Their concern is substantiated by the learning opportunity content, procedures and retention of constructed knowledge in the prescribed formats. Continuous awareness of the state of affairs is essential to educators and learners for appropriate actions, behaviour and adaptations to achieve optimum learning (Van der Horst and McDonald, 1997:171). Assessment of learning during and after a learning opportunity has specific purposes requiring different instruments and timing for interpretation and analysis of the situation in a quest for perspective. Development, remediation, judgment and evidence accumulation are the purposes of assessment (Wong, 2006:956, 957).

Reliable and valid instruments are required for effective assessment of learner achievements to attain optimum value for educational intervention and judgement. These criteria are more critical for summative (judgemental) assessment because their results will determine the unit and grade progressions of learners. Reliability of an assessment instrument signifies the ability to reproduce results effectively and ensure consistent judgements. Validity of an instrument denotes ability to measure what it is supposed to measure (Wong, 2006:957; Killen, 2010:351, 354).

Assessment is an integral part of education featuring in presentations, end of event and end of programme for the specific purposes. Fully integrated learning and assessment are key contributors to the process and outcome of education. Criteria for the assessment are derived from the unit standards as integral parts of the curriculum, equivalent to the assessment strategies documented in conventional curricula (De Villers, 2001:5 of 13; Appendix K).

6.4 MOTIVATION FOR UNSUCCESSFUL SCHOOL LEAVERS' EDUCATION IN SOUTH AFRICA

The essence of the proposed curriculum is ***effective learning*** and the strategy ***learning-by-doing***, i.e. proficiency being acquired by actively executing specific procedures incorporating integrated declarative and procedural knowledge denoting sensible, worthwhile cognitive, psychomotor and affective skills – knowledge, skills and values (Clark, 1999). Learners should be lured into participation with hands-on activities and presented the opportunities of ***educational foundation construction*** in pursuit of ***capacity building***. Unlike the freedom of a transdisciplinary approach and the occupational orientation of the project method for apprentices, the education envisaged by this curriculum evolves from practica focusing on generic skills, transferable to diverse activities.

6.4.1 FUNCTIONALITY OF SOUTH AFRICAN EDUCATION

The South African education system is failing large numbers of learners (cf. 1.1). Current measures to address the educational situation at FET colleges are cosmetic in nature (cf. 2.5.1; 2.3.2.2). The very essence of education, learning and consequential cognitive and perceptual-motor development, does not get precedence. A school/FET college certificate, regardless of the level, should be proof of competence, but this is not the case.

South African education reveals a distinction between "knowing that" (declarative knowledge) and "knowing how" (procedural knowledge) in terms of *knowledge, skills* and *values* and furthermore between *education* and *training*. *Knowledge* is cognitive attributes; *skills* are psychomotor ability and *values* primarily attitude and affective attributes. Transdisciplinary integration of education acknowledges the declarative knowledge initiation and foundation of procedural knowledge acquisition establishing real declarative and procedural knowledge integration (cf. 4.2.3.3; 6.3.4.1). Relevance and significance are natural attributes in practicum-based presentations.

Serious consideration should be given to the very essence of education, learning. Implement correctional steps from Grade R and the basics of education in an endeavour to establish a culture of learning and responsibility (cf. 1.1; 1.2.1).

6.4.2 EDUCATION BEYOND DEMAND OF TRADE AND INDUSTRY IN THE RSA

Education on trade and industry demand cannot be the only motivation for provision of education. Trade and industry exist and develop because of society and not vice versa. Education throughout history had a major purpose: survival; but survival relies on development. Personal development cannot be excluded from education. Up to a point, education focuses on personal development as foundation for further development. Insufficient development leaves unsuccessful school leavers in a situation where they cannot achieve the level of development required for entering into NQF 2 education that is more specific, or into employment. A balance needs to be found between the educational needs of society and the manpower needs of trade and industry. Education on trade and industry demands will not solve the socioeconomic problems encountered by unsuccessful school leavers.

Unsuccessful school leavers need to be educated. Selecting education content within the boundaries of vocational education, acknowledging their specific situation, is a practicable conclusion. The envisaged education is not in response to industrial or economic development, but to address a situation that can become a stumbling block to socioeconomic progress (Gower, 2009). Educating such learners is preferable to accepting the *status quo* and simply waiting for the economy to create a demand for unskilled and poorly skilled people. School dropout of this magnitude and the inability to address the educational needs of these learners constitute an unfavourable socioeconomic situation hampering South Africa's development.

6.4.3 UNSUCCESSFUL SCHOOL LEAVERS – A SOCIAL PROBLEM

The high number of unsuccessful school leavers is an educational problem. Increasing the school throughput with substantial improvement in education may reduce unsuccessful school leavers numbers in future, but there will always be a dropout figure. Learners already out of the school system are another facet of the problem that should be addressed promptly. Unfortunately, expecting FET colleges to successfully educate unsuccessful school leavers with the means at their disposal (NC(V) etc.), has already been proved a failure.

Unsuccessful school leavers also constitute a social problem more serious than any comparable situation in South African history. These youngsters have virtually nothing to resort to other than hanging around. Higher education is out of reach, further education does not satisfy expectations and employment prospects are poor (Cloete et al, 2009:2). Returning them to education that can improve knowledge, skills and qualifications, enabling them to attempt NC(V) (vocational education), apprenticeships, learnerships, lower level skills or entrepreneurships may have a significant impact on the situation. The alternative – doing nothing – is a "social time bomb" (Gower, 2009).

6.4.4 UNSUCCESSFUL SCHOOL LEAVERS – AN ECONOMICAL PROBLEM

Unsuccessful school leavers are also an economic problem. More economically active citizens mean fewer social welfare dependants. Self-sustaining citizens on the lowest levels of economic activity would create new economic environments, generate more opportunities and establish a base for small business development. The United States of America's Senate Committee on Small Business and Entrepreneurship (2010) regards small businesses and entrepreneurships an engine (driving force) for economic growth and job creation.

Education to improve the prospects of the less fortunate is not a new concept. It can be done again to improve the situation of unsuccessful school leavers, but a mind shift is needed. Society and the authorities should accept that these learners have special educational needs. Education to overcome their learning barriers and address their needs should be established regardless of stereotypes or negative connotations. In the past, recourse to manual skills was a solution. It can be again. Curricula can be designed to address the situation and simultaneously create options for re-entry into further education.

This endeavour should be a governmental responsibility. Although there are examples of where cities (in Europe, for instance) and organisations in the private sector get involved in education, this is unlikely to happen in South Africa at present and at the scale needed. Government has facilities, equipment and expertise at FET colleges that can be utilised with minor adaptations. Adding means and personnel to the existing institutions will be a more viable option than creating an independent educational system (second chance education). It is a responsibility that should not be taken lightly.

The private sector, being profit driven, will not get involved in lower level education without financial incentives. SETA funds are available for learnerships, apprenticeships and equivalent skills training, and learners must qualify before grants became payable, but not in the immediate scope of unsuccessful school leavers. These are however, qualifications higher than the level at which unsuccessful school leavers education must be pegged and therefore out of reach to benefit them. Unsuccessful school leavers outnumbered these options by 48 to 1 –

600 000 unsuccessful school leavers to 12 500 learnership/apprenticeship opportunities annually (Van der Berg et al, 2011:4; Graph 1.1). The field of unsuccessful school leavers' education should be extended to cater for them across the spectrum of vocational education.

6.5 RESEARCH CONCERNS

The study reveals various significant aspects that evoke further curiosity. It does not cover context, situated, concrete and personal influences on construction of knowledge. Context includes culture, language and media. Language, identified as one of the problem areas in learners' proficiency, is an educational issue to be considered on national level. This involves language policy and beliefs. These aspects were not included in the scope of this study.

Interviews with learners could have contributed further to learner educational profile, their shortcomings and learning barriers. Logistics and finances rendered such an exercise not feasible, but it would have enriched the study significantly.

Improved comprehension of the learning barriers unsuccessful school leavers encounter would have been possible with psychometric and aptitude tests and psychological research. Psychometric and aptitude tests could further contribute to a better understanding of the learners and their situation. It was, however, beyond the means and scope of this study because the learners are spread across the country, and the mentioned restrictions apply here too.

No distinction was made between male and female learners. However, interviewees mentioned female learners' dedication and successes in workshop activities. It would be interesting to see how the genders compare.

FET college statistics are insufficient. Learners' previous qualifications and performances were not readily available. The records of accomplishment of individuals, starting with school results, enabling evaluation and correlation is insufficient. It was also not possible to determine the number of first enrolments and the number of completions and terminations of studies. FET colleges' recording of statistical data needs to be upgraded to enable clearer pictures of their educational scenarios, e.g. progress, throughput, educational foundation/progress relationship.

6.6 RECOMMENDATIONS FOR EDUCATION IN SOUTH AFRICA

The following recommendations are considered important aspects in South African education that need attention. Proposing a curriculum for unsuccessful school leavers is an attempt to improve the educational situation of learners with relevant aptitudes and interests and encourage further research and development of a range of curricula to afford all of these learners opportunities in "further" education. NEET youngsters can also benefit from the proposed "second chance education" for unsuccessful school leavers

6.6.1 ESTABLISHMENT OF UNSUCCESSFUL SCHOOL LEAVERS' EDUCATION

Considering the situation of unsuccessful school leavers and educational programmes currently available, it is recommended that "second chance education" be established as an additional component to provide education for the learners who find it difficult to cope in the linguistic-logic predilection of mainstream education. Improving the educational situation of unsuccessful school leavers requires education to accommodate them. They need education with a different approach and presentation strategies based on sound educational fundamentals.

Mechanical skills can only be one of the programmes within this component of education. More equivalent programmes need to be developed to cover the scope of unsuccessful school leavers' aptitudes and interests, considering their prospects. Unsuccessful school leavers' education will be a permanent component of South African education because school dropout is not a temporary occurrence. Only the magnitude of the problem can change.

An additional component to the educational system of South Africa, to provide for learners with an aptitude different from the requirements of mainstream school and college curricula, is a necessity. Transdisciplinary practicum-based education should cater for all those learners encountering problems to respond effectively to the existing curricula. Practica projects can be any workplace-based activity, e.g. from office to workshop activities, and can therefore cover the scope of vocational education currently offered at FET colleges and beyond.

6.6.2 ACCOMMODATION OF LEARNER DIFFERENCES

The notion of learner differences in education is, inter alia, associated with mental capacity (intelligence) and aptitude of learners. Although not the only attributes, these are realities educators should take cognisance of.

Redefining intelligence leads to the assumption that all learners can learn if the educator can match his teaching style with the specific "intelligence" or learning style of the learner – match some teaching method with the "intelligence" or learning style of the learner or allow sufficient time. OBE, "multiple intelligences", learning style "theories" and the Revised National Curriculum Statement all contribute to the establishment of the notion that all learners are "mentally equal," but differ in other ways. All learners are "intelligent" but in different ways *"It's not how smart you are, but how you are smart"* (McKenzie, 2002), is an insinuation that causes educational problems. The proponents of these theories did not explicitly make such statements, but the interpretations thereof are problematic, leading to unfounded time-consuming expensive educational practices (Pashler, McDaniel, Rohrer and Bjork, 2009:3, 4 of 26).

The policy of unitary, all-inclusive education is failing the children of South Africa. It resembles unfounded assumptions derived from unqualified notions: e.g. "All learners can learn and succeed...", "multiple intelligences", "71 learning style theories divided into a multitude of styles and a meshing assumption" (Spady, 1994:9; Gardner, 1999:41 – 43). The Revised National Curriculum Statement adds to this unfortunate perception with, "a high level of knowledge and skills for all" (RSA, 2002).

Reality has it differently. Learners are not born equal. Considering intelligence (mental capacity) and other abilities of different learners equal and only differing in mode, is misjudging learner potential and the entire educational scenario. It is exactly these differences that must be taken into account when designing education, curricula and teaching strategies. Diversity in a classroom should not be beyond control. A bigger diversity of intelligences, aptitudes and abilities in one group demands more adaptations in strategy and presentation and may become impracticable.

Learners are born different: different genetic compositions, different physical features and abilities, different mental capacities, different aptitudes with a range of different abilities. Negating these facts and expecting everybody to perform and achieve success in equivalent educational programmes, is beyond comprehension. Inclusive education may be cheaper than differentiated education, but it sacrifices the majority of the South African school population annually.

Learners should develop to a level as close as possible to their full potential, but this can only be achieved in differentiated education. Differentiated education does not refer to subject differentiation, e.g. higher-grade, standard-grade and lower-grade mathematics (functional/ mathematics literacy). Educational differentiation should be based on mental capacity, aptitude and psychomotor ability. Accommodating learners in education accordingly will be a great improvement. Unsuccessful school leavers will not succeed in inclusive mainstream education regardless of the mode.

The following aspects of reality should be seriously considered:

- Learners have different mental capacities and physical abilities
- Learners have different aptitudes (inborn capabilities)
- IQ is a fairly good predictor of educational performance although fallible

- Aptitude tests can improve career guidance, course choices, subject choices
- Learning is a complex psychological process and not just absorption of information
- Learning is a personal mental procedure – educators can only facilitate
- Adopt a "mathematics teaching strategy" emphasising relevance, application and usability
- Teaching should facilitate learning – transformation of information into useable knowledge
- Knowledge and skills integration is more complex than offering them simultaneously
- Reject multiple intelligences as premise for education design
- Reject learning style theories as premise for education strategy planning
- Elaborate on the concept of facilitation. Putting learners and learning in the spotlight (learner-centred education) demands more from the educator than does teacher-centred education

Judgements on intelligence and aptitude cannot be made on mere evaluation of educational performance. There are too many factors involved in cognitive and perceptual-motor development. Psychometric and aptitude tests are essential for placement of learners because they can provide some evidence of cognitive and perceptual-motor capacity and enhance success prediction.

6.6.3 UNIQUENESS OF THE SOUTH AFRICAN EDUCATIONAL SITUATION

The South African educational scenario is different from any other and therefore needs a different national education strategy. Provision must be made for learner diversity on national and regional level by means of an assortment of facilities. Learners must be afforded the opportunity for optimum development through differentiated education. All-inclusive education adds a burden on education for educators to handle. The bigger the diversity in a classroom, the more difficult it becomes for an educator to address the needs of every individual.

Education for the majority of learners should be rectified from the fundamentals of education. Currently, only window dressing is done (cf. 1.1). Chopping and changing curricula/programmes, lowering pass criteria and changing certification criteria, are some of the measures that have been taken to make South African education look good. "Look good" virtually implies a high matric pass rate regardless (and often contradicting) the quality of the education or proficiency. Very high value is placed on the matric pass rate and very little, if any, on learning and learner competence – the very essence of OBE. Ironically, competence is central in the philosophy of OBE, but school qualifications are not substantiated by the competences presumed (Van der Berg et al, 2011:4, 13). The mentioned changes will not improve education or the proficiency of learners. The quality of education needs to be upgraded throughout the school and college system including preschool education. Informal education (at-home preschool (cf. 1.7)) should be supplemented with extensive and comprehensive pre-school education.

A contribution to a solution for South Africa's educational dilemma can be found in William Arthur Ward's comment:

- "The mediocre teacher tells."
- "The good teacher explains."
- "The superior teacher demonstrates."
- "The great teacher inspires." (Feldman and PcPhee, 2008:132)

It is the responsibility of educators to ensure that learners ***learn effectively*** and be competent before promoting them (cf. 6.3.6.1.1).

Education authorities need to stop copying and replicating foreign educational philosophies and practices. What is appropriate in the United States of America, United Kingdom, Australia or New Zealand is not necessarily suitable for the South African educational situation. The South African education experiment, based on foreign educational models, has been proven a failure – poor learner throughput, low quality education and mismatched competence and qualifications.

6.6.4 LEGACY OF ANCIENT CIVILISATIONS

Stop trying to shed off the legacy of ancient civilisations by "lifting" vocational education standards and changing the names related to vocational education and ***address the needs of SA's youth instead*** (cf. 2.2.1). Changing names, trade school to technical high school; Technical College to College to FET College; College for Advanced Technical Education to Technikon to University of Technology, inter alia, did not improve the education offered. Technical education, throughout the spectrum, is supposed to advance technology and improve the standard of living, but the name changes did not make any contribution to education improvement. With high quality vocational education proficiency of the graduates and excellence will counter negative connotations in the workplace and society.

6.7 SUGGESTIONS FOR FURTHER RESEARCH

Research themes that evoked interest during the study, but could not be incorporated, are mentioned. They would supplement the information on the educational situation of unsuccessful school leavers in South Africa and support the proposal of "second chance" education. Improving perspective on school retention, career guidance, relationship of vocational education and labour market needs, educators' role in vocational education, micro-entrepreneurships establishment and small business survival, integrated education and the duration of knowledge construction would benefit vocational education in South Africa.

6.7.1 SOUTH AFRICA'S SCHOOL RETENTION RATE

Research into the reasons for school dropout is the complementary facet of addressing the unsuccessful school leavers' situation. The factors revealed in this study are inadequate for definite conclusions to be drawn regarding this aspect of school dropout. The initial target should be to reduce the South African school dropout rate to the UNESCO norm of 21%. Reasons revealed by such research could help in countering the high level of dropout.

It is questionable whether the majority of South African educators understand the fundamentals of outcomes-based education, or whether they fully comprehend the meaning of *knowledge, skills and values* and acquisition thereof. Do they analyse the outcomes before venturing into learning opportunity planning? Do they understand the role of facilitator in an educational scenario on NQF 2 – NQF 4 level? The throughput in South African education presumes negative answers to these questions.

6.7.2 CAREER GUIDANCE AND APPROPRIATE PLACEMENT OF LEARNERS

Complementary to research into school dropout, a study could be done regarding methods to get Grade 9 learners with aptitudes for, and interests in specific occupations to enrol in relevant vocational education at FET colleges. Learners' interests, aptitudes and prospects should take precedence over other considerations, but the high premium placed on a matric qualification will continue to make it difficult to get capable learners enrolled in vocational education programmes at FET colleges. The proficiency of learners currently enrolling in NC(V) engineering programmes at FET colleges creates the impression that schools do not want learners with aptitudes for vocational education and higher mental capacities to leave for vocational education.

Guidance for Grade 9 learners to ensure appropriate placement at FET colleges and FET schools should be investigated. Improving career guidance should be based on closer cooperation between schools and FET colleges, mutual responsibilities and shared information. The research revealed that school educators and career guidance personnel do not know the purpose, programmes, programme standards or functioning of FET colleges. Despite millennia of experience and research, the legacy of ancient education, *practical training is for those with less mental capacity*, prevails to the detriment of vocational education. Society's (and school educators' and career guidance personnel's) concept of FET college education is founded in this legacy of ancient civilisations.

6.7.3 VOCATIONAL EDUCATION AND LABOUR MARKET NEEDS

Research comparing labour market demands and educational institution output in terms of numbers, competences and qualifications, is of paramount importance. FET colleges and the authorities are out of touch with reality – ±30 000 new entrants in engineering studies, but only 12 500 positions are available annually. Skills shortages are reported despite decades of abundance of learners in vocational (engineering) education...

Proper placement (enrolment in programmes) is not possible without the mentioned information. This research is a prerequisite for further changes to vocational education and education in general.

Research to correlate unsuccessful school leavers' education and the demand for lower-level skills will be a valuable contribution to the assessment of the situation. Lower-level skills occupations like artisans' assistants, handymen, strippers and component fitters in the motor maintenance industry are worthwhile prospects.

6.7.4 NC(V) PROGRAMMES AND EDUCATORS' ROLE IN VOCATIONAL EDUCATION

Another aspect of FET college education, the effect of administrative duties on success in the NC(V) programmes, urgently needs to be investigated. Such research can reveal valuable information for the improvement of vocational education.

Added to the dejection accompanying NC(V) education and OBE, is the confirmation of excessive control in terms of numerous forms to be completed by educators. Excessive control and burden of consequential administration take up valuable education time rendering educators, administrative assistants. Investigation, aiming at limiting this aspect of educator duties to an absolute minimum, should be high priority.

6.7.5 THE INFLUENCE OF MICRO-ENTREPRENEURSHIPS ON SMALL BUSINESSES

The effect that micro-entrepreneurships and micro-businesses may have on businesses in South Africa and the economy should be thoroughly researched. Opponents of the idea of establishing micro-entrepreneurships may be rejecting it on the basis of an opinion and not on reality or scientific fact. The United States of America's Senate Committee on Small Business and Entrepreneurship (2010) regard small businesses and entrepreneurships as an "engine" (driving force) in economy stimulation and job creation, as previously stated in this study.

South African research into this aspect could clarify the influences of micro-entrepreneurships and micro-businesses on unsuccessful school leavers' socioeconomic situation and on the business climate. Informal businesses may contribute to the economy rather than threaten other businesses. A low-level, low-capital outlay economic sector should be developed.

6.7.6 INTEGRATED EDUCATION

Transdisciplinary and interdisciplinary education and the effects such approaches may have on South African education needs to be investigated thoroughly. NC(V) is supposed to be interdisciplinary education, but is there evidence of the practical application of the approach? These approaches may contribute to the improvement of vocational education at FET colleges. Research, revealing the true situation in vocational education, can contribute to the implementation of an approach conducive to effective education at FET colleges.

6.7.7 PSYCHOLOGICAL RESEARCH IN LEARNING BARRIERS OF UNSUCCESSFUL SCHOOL LEAVERS (SCHOOL DROPOUTS)

The inability of unsuccessful school leavers to learn effectively is a major concern. There is much more to learning deficiency than could be disclosed with the learning barriers in this research, considering its aim. It was not possible to venture into socioeconomic, psychological and comprehensive educational factors influencing the educational situation and ineffective learning of unsuccessful school leavers.

Research in the psychological factors contributing to ineffective learning of unsuccessful school leavers can enhance understanding of the phenomenon and provide valuable information in an attempt to improve the quality of their school education and reduce school dropout. The envisaged information, in addition to the reasons disclosed by this study, can also benefit FET college education regarding remedial measures to be taken.

6.7.8 PSYCHOLOGICAL RESEARCH IN THE DURATION OF KNOWLEDGE CONSTRUCTION ("INCUBATION PERIOD")

The duration of knowledge construction, beyond memorisation (ability to reproduce) to the point of comprehension ("incubation period"), in different people may disclose the reasons for the outliers in IQ and education performance correlation. Research to determine this "delay" in knowledge processing (beyond monitoring and STM) and correlation with psychometric scores can enhance understanding of human learning processes and add another facet to learner differences.

Investigating the key elements of IQ, power and speed of metal performance, may reveal excellent power combined with slow response or vice versa and ensuing lower IQ score. Some learners may have the "power", but lack the "speed" in mental processing resulting in lower IQ scores, but have excellent educational performances. This may be another consideration in learner differences.

6.8 PERCEPTIONS TO PONDER

Skills (procedural knowledge) have direct marketing value. Declarative knowledge must first be converted into skills to have market value. Performance in the workplace is the ultimate test for education.

If second chance education is not part of the solution, what is the alternative? If micro-entrepreneurships are not feasible, what are feasible options? It will be far better to propose alternative options, rather than to reject them outright. Unsuccessful school leavers must be kept "occupied" in education to develop into economically active and responsible citizens. Micro-entrepreneurships have the potential to be incorporated in the final stages of education and progress from education-dependent enterprises into fully independent self-sustaining entrepreneurships at "termination" of education (school leaving).

In the South African context, 600 000 unsuccessful school leavers annually accumulates to 1,2 million in two years and 6 000 000 additional "welfare candidates" in a decade. The alternative is millions of economically active citizens added to the South African economy in a decade. This is obviously oversimplification, but intended to emphasise the urgency of unsuccessful school leavers' education.

6.9 CONCLUSION

"Second chance" education for unsuccessful school leavers is imperative because the alternatives are socioeconomically unacceptable. The current practice of assigning FET colleges the task of educating unsuccessful school leavers in NC(V) (or NATED) has proven unsuccessful. Leaving them uneducated, which is virtually what is happening currently, is an option destined to render South Africa welfare-state status with predicable political consequences.

Mechanical Skills for unsuccessful school leavers is transdisciplinary practicum-based education founded on a constructivist psychological learning theory. Practicum-based teaching strategies cover integrated knowledge, skills and values development of learners, emphasising relevance, application and practicability. Practicum is an opportunity for integrated learning and skills acquisition. Skills acquisition is just another form of knowledge construction.

South African education still exhibits remnants of primitive education. Education is utilised to shape and develop society to conform to the ideology of the ruling party – social reform, favouring the ruling party's ideology. There is no room for individuality, innovation or personal excellence. In ancient Chinese higher education examinations, the intention was to eliminate candidates until only the desired number of students passed (Monroe, 1956:36). South African education aims at inclusion of everybody, which is good, but progression for everybody in inclusive mainstream education is currently at the expense of quality and competence. Low quality education results in remedial education imposed upon institutions with different purposes and focuses. It is not the responsibility of further educational institutions and higher education to undertake remedial education to become all-inclusive.

This study emphasises the urgency of addressing the educational needs of unsuccessful school leavers, which can be extended to include NEET youngsters and provision of quality education. A curriculum was designed to accommodate unsuccessful school leavers with relevant interests and encourage design of equivalent curricula to cover the scope of learner aptitudes and interest (Appendices J and K).

FET colleges, in urgent need for alternative skills development curricula according to the interviewees (F, G, H, I, J, L, N and S) and personnel respondents (cf. Graph 5.15), should welcome this proposal encompassing introduction into engineering education, bridging into apprenticeships, learnerships and NQF 2 vocational education, lower-level skills occupations and entrepreneurships. Supplementing the skills development feature of the curriculum, the educational foundation construction promoted, is equally important to the development of unsuccessful school leavers.

"Education is that which remains when one has forgotten everything learned in school." (Einstein, 1954). This notion favours transdisciplinary practicum-based education.

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QUESTIONNAIRE CONSTRUCTS COLLEGE (PERSONNEL)

(P = Personnel; A/B/C/D = Division)

PA. **Learner educational profile**

PA.1. Learner age

PA.3. Predisposition

PA.4-8. Education type preference – academic vs. practical hands-on

PA.2. Performance estimation

PA.9. Innovation estimation

PA.10. Reasons for learners' preferences for engineering at FET colleges (open-ended)

PB. **Opportunities for unsuccessful school leavers in engineering studies**

PB.1. Enrolment policy

PB.2-4. Qualification prospect estimation

PC. **FET college engineering programmes**

PC.10-11. Qualification standard estimation

PC.16. Subject focus of courses

PC.21-22. NC(V) is artisan training

PC.22. Practical training in NC(V) (perceptions)

PC. **Nonformal programmes**

PC.6. Existence of unsuccessful school leavers' education

PC.1. Unsuccessful school leavers' education should be part of engineering studies

PC.2. Only NC(V) at FET colleges

PC.3. Colleges should focus on business and community

PC.4. Colleges should develop their own skills programmes

PC.5. DOE must develop skills programmes for colleges

PC.8-9, 12. Justification for additional skills programmes

PC.13-15. Educational approach for unsuccessful school leavers education

PC.17. **Labour market and employment**

PC.18, 19. FET college responsiveness to local community needs

PD. **Entrepreneurial skills**

PD.1. Entrepreneurial skills development

PD.2. Intergated skills development

OPEN-ENDED QUESTIONS

PA.10. Reasons for enrolment in engineering studies at FET colleges

PD.3. Entrepreneurial attributes (open-ended)

PD.4. Viable entrepreneurial enterprises (open-ended)

QUESTIONNAIRE CONSTRUCTS LEARNERS (Appendix H)

(L = learner; A/D = Division)

LA. **Learner educational profile**

LA.1. School grade

LA.2. Learning preferences

LA.3. Aptitude profile

LA.4. Learning barriers

LA.5. Educational dispensation

LA.6. Responsibility for own education

LA.7 – 12. Educational approach preferences

LA.13. Performance evaluation

LA.14. Innovation evaluation

LD. **Entrepreneurial prospects**

LD.1. Prospects estimation

LD.2. Entrepreneurial predisposition

OPEN-ENDED QUESTIONS

LA.14. Motivation for performance evaluation

LA.16. Reasons for enrolment in engineering studies at FET colleges

QUESTIONNAIRE DIVISIONS

Questionnaire outline for personnel and learner questionnaires

- Concentrating on average age, academic performance and ability, the intention of section A was to collect data that could be utilised to become acquainted with the situation of the learners and establish a fair educational profile of an average unsuccessful school leavers in engineering studies. Adding to the scenario, the engineering examination results and information from the literature study elucidated the situation of unsuccessful school leavers in engineering studies.
- Section B deal with two facets of FET college education: the enrolment policy and elementary engineering educational features. The main concern is appropriate education for unsuccessful school leavers, therefore the suitability of NC(V) for unsuccessful school leavers had to be established.
- Section C consists of further investigation into (NC(V) programmes and their status. Analysing, interpreting and conceptualising the data are an essential part in the confirmation or rejection of the assumption that NC(V) covers the spectrum from orientation towards engineering education, through entrepreneurship to artisanship (Department of Education, 2007b:11, 13).
- A further function of Section C is to inquire about nonformal programmes at FET colleges and the college division in which unsuccessful school leavers education should be accommodated. It inquires about existing suitable education for unsuccessful school leavers and aspects of nonformal education in engineering studies at FET colleges. Awareness of labour market needs and responsiveness to community needs are also included in the inquiry.
- Section D inquires about entrepreneurship attributes and viable enterprises. Entrepreneurial prospects are one of the key issues in the justification of alternative education for unsuccessful school leavers. Employment figures predict poor prospects, leaving learners very limited choices.

DIFFERENTIATION OF INTERVIEW DATA (I)

I.1. Learner Educational Profile

I.1.1. School level of new entrants in engineering studies
I.1.2. Reasons for enrolling in NC(V)
I.1.3. Educational ability/learning ability/aptitude profile of learners
I.1.4. Language proficiency
I.1.5. Mathematical proficiency
I.1.6. Consequence of preceding education
I.1.7. Vocational disposition
I.1.8. Educational predisposition of learners
I.1.9. Frame of mind
I.1.10. Attitude and behaviour of the learners in classrooms/educational sessions
I.1.11. Motivation and self-discipline
I.1.12. Emotional disposition
I.1.13. Socio-economic profile

I.2. Most Appropriate Education for School Dropouts

I.2.1. Practical hands-on training with essential support knowledge
I.2.2. Transdisciplinary – practical/project-based
I.2.3. Interdisciplinary education
I.2.4. Short skills programmes
I.2.5. Bridging course
I.2.6. Entrepreneurships

I.3. Aims of Appropriate Education

I.3.1. Skills/Proficiency
I.3.2. Improve employability

I.4. Actual Learning Preference of the Learners

I.4.1. Practical hands-on training
I.4.2. Memorisation – rote learning (classical learning)
I.4.3. Group work
I.4.4. Peer support
I.4.5. Examination coaching/exercising
I.4.6. Visual learners
I.4.7. Independent research and study

I.5. Most Appropriate Teaching Style for Educators

I.5.1. Combination of styles – pragmatic strategy

I.5.2. Demonstrator/personal model
I.5.3. Chalk and talk

I.6. Most Appropriate Educational Methods

I.6.1. Pragmatic approach
I.6.2. Group work
I.6.3. Lecture
I.6.4. Combination of methods
I.6.5. Project method
I.6.6. Occupation oriented
I.6.7. OBE

I.7. Most Appropriate Educational Techniques

I.7.1. Multiple sensory experiences
I.7.2. Classic repetition and memorisation
I.7.3. Comprehension
I.7.4. Group discussions
I.7.5. Group work
I.7.6. Pragmatic teaching
I.7.7. Media
I.7.8. Peer teaching
I.7.9. Individualisation
I.7.10. Pertinent contexts
I.7.11. Mental preparation

I.8. Linking New Knowledge with Internalised Knowledge (Constructivist approach)

I.9. Institutions Most Suitable for Educating Unsuccessful School-leavers

I.10. FET Colleges as Institutions for Educating Unsuccessful School-leavers

I.11. Feasibility of Special Education for Unsuccessful School-leavers

I.12. College Enrolment Policy

I.12.1. College has a policy
I.12.2. College does not have a policy
I.12.3. Policy determined by the department of education

I.13. Perceptions of personnel regarding NC(V)engineering programmes

I.13.1. Purpose/Aims of NC(V)
I.13.2. Standard of NC(V)
I.13.3. Objections against NC(V)

Table 3.1. *Revised Bloom's Taxonomy*

The Knowledge Dimension	**The Cognitive Process Dimension**					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge	List	Summarize	Classify	Order	Rank	Combine
Conceptual Knowledge	Describe	Interpret	Experiment	Explain	Assess	Plan
Procedural Knowledge	Tabulate	Predict	Calculate	Differentiate	Conclude	Compose
Meta-Cognitive Knowledge	Appropriate Use	Execute	Construct	Achieve	Action	Actualize

REMEMBER

Remember

Retrieve relevant knowledge from long-term memory.

Recognizing

Recognize the dates of important events in US history.

Recalling

Recall the dates of important events in US history

Factual Knowledge

The basic elements students must know to be acquainted with a discipline or solve problems in it.

Knowledge of terminology technical vocabulary, musical symbols

Knowledge of specific details and elements Major natural resources, reliable sources of information

List

To identify the names, professional identities, and ideas of two or three of the major western sexologists

Conceptual Knowledge

The interrelationships among the basic elements within a larger structure that enable them to function together.

Knowledge of classifications and categories periods of geologic time

Knowledge of principles and generalizations Pythagorean Theorem, law of supply and demand

Knowledge of theories, models and structures theory of evolution, structure of congress

Describe

Describe the history (and pre-history) of wild-land fire.

Procedural Knowledge

How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.

Knowledge of subject-specific skills and algorithms painting with watercolours, whole-number division

Knowledge of subject-specific techniques and methods interviewing techniques, scientific method

Knowledge of criteria for determining when to use appropriate procedures when to apply Newton's second law, when to use a particular method of estimation

Tabulate

Students will be able to demonstrate knowledge of each step a bill takes on its way through the legislative system.

Meta-Cognitive Knowledge

Knowledge of cognition in general as well as awareness and knowledge of one's own cognition.

Strategic knowledge outlining as a means of capturing the structure of a unit of subject matter in a textbook

Cognitive tasks knowledge of the different types of tests, cognitive demands of different tasks

Self-knowledge knowledge that critiquing essays is a personal strength, whereas writing essays is a personal weakness; awareness of one's own knowledge level.

Appropriate Use of Terms

Use the Science of Foods terminology in relation to discussing foods or food products

UNDERSTAND

Construct meaning from instructional messages, including oral, written, and graphic communication.

Interpreting

Paraphrase important speeches and documents

Exemplifying

Give examples of various artistic painting styles

Classifying

Classify observed or described cases of mental disorders)

Summarizing

Write a short summary of the events portrayed on videotapes)

Inferring

In learning a foreign language, infer grammatical principles from examples)

Comparing

Compare historical events to contemporary situations)

Explaining

Explain the causes of important eighteenth-century events in France

Factual Knowledge

Summarize

Summarize an article, speech or book in the students own words.

Conceptual Knowledge

Interpret

Consider the connection between structure of the landscape and function of ecosystems within that landscape.

Procedural Knowledge

Predict

Predict the future of political activism among certain demographic groups in the United States

Meta-Cognitive Knowledge

Execute

As a result of this class, students will be able to execute and demonstrate to others, complex conservation techniques in their own area.

APPLY

Carry out or use a procedure in a given situation

Executing

Divide one whole number by another whole number, both with multiple digits.

Implementing

Determine in which situations Newton's second law is appropriate.

Factual Knowledge

Classify

Understand fund raising and grant-making as function of the donor/beneficiary relationship and to apply theoretical principles to the act of fund raising.

Conceptual Knowledge

Experiment

Use the chemistry and composition of foods to explain how it relates to the quality of a food product.

Procedural Knowledge

Calculate

Devise and put into use, a method of counting votes in an election

Meta-Cognitive Knowledge

Construct

Complete a theme-based or place-based historical reconstruction of a topic or site.

ANALYZE

Break material into constituent parts and determine how parts relate to one another and to an overall structure or purpose.

Differentiating

Distinguish between relevant and irrelevant numbers in a mathematical word problem)

Organizing

Structure evidence in a historical description into evidence for or against a particular historical explanation

Attributing

Determine the point of view of the author of an essay in terms of his or her political perspective

Factual Knowledge

Order

Students will be able to place important events in the order in which they happened.

Conceptual Knowledge

Explain

Explain why an understanding of wildland fire ecology is important.

Procedural Knowledge

Differentiate

Differentiate between the terms **gender** and **sex** and understand the differences.

Meta-Cognitive Knowledge

Achieve

Students will achieve a level of understanding regarding their personal lifestyles and how the choices they make in their own lives change the environment.

EVALUATE

Make judgements based on criteria and standards.

Checking

Determine whether a scientist's conclusions follow from observed data

Critiquing

Judge which of two methods is the best way to solve a given problem.

Factual Knowledge

Rank

Students will be able to rank current political issues on how they feel emphasis should be placed

Conceptual Knowledge

Assess

Make judgements on information, method and technique based on rules and facts.

Procedural Knowledge

Conclude

Given a set of occurrences, students will be able to conclude which outcome is most likely.

Meta-Cognitive Knowledge

Action

Apply concepts learned in class to implement a recycling program.

CREATE

Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure.

Generating

Generate hypotheses to account for an observed phenomenon

Planning

Plan a research paper on a given historical topic

Producing

Build habitats for certain species for certain purposes

Factual Knowledge

Combine

Students will be able to combine healthy ingredients into an entire meal.

Conceptual Knowledge

Plan

Students will make personal and professional decisions regarding their own participation with non-profit organizations, third sector professions, citizen leadership, voluntary action, philanthropic studies and research, graduate education, volunteering and gifting and other philanthropic activities.

Procedural Knowledge

Compose

Given a set of guidelines, students will be able to compose poetry, which follows the constraints set out.

Meta-Cognitive Knowledge

Actualise

Engage in activism on behalf of social justice for women.

APPENDIX E

CURRICULUM INTEGRATION

1. Continuum of curriculum integration (Nordahl and Kofoed, 2008):

Transdisciplinary
Transcends disciplines - starts with a problem

Interdisciplinary
Integration to solve a specific problem

Multidisciplinary
Juxtaposition of disciplines –

Crossdisciplinary
Discipline viewed from the perspective of another

Intradisciplinary
Single discipline studies – subjects combined in a single discipline (cf. 2. Fusion)

2. Continuum of curriculum integration (Drake, 1998: 20):

Transdisciplinary
Transcends disciplines (Problem/Story/Project)

Interdisciplinary
Collaboration and synchronisation

Multidisciplinary
Subjects taught separately, but connected through a theme in same timeframe. Learners are expected to make their own connections.

Subject
Sub-disciplines integrated into a single subject

Fusion
Topic(s) inserted into several subject areas – no collaboration, no synchronisation

Traditional
Subject focus

3. Continuum of mechanical skills curriculum integration (*Derived form 1 and 2*)

Transdisciplinary
Practicum-based curriculum

Interdisciplinary
Collaboration and synchronised work schemes. Cooperative projects are possible

Multidisciplinary
Subjects taught separately containing corresponding themes, but studied from subject specific perspectives.

Subject integration
Trade or subject theory and practice taught simultaneously. No correlation amongst subjects or synchronisation of work schemes

Conventional
Subject focus – no collaboration, no synchronisation

FET COLLEGE NC(V) PROGRAMMES

NC(V) L 2	NC(V) L3	NC(V) L4	FACULTY
Civil Engineering & Building Construction	Civil Engineering & Building Construction	Civil Engineering & Building Construction	Eng
Electrical Infrastructure Construction	Electrical Infrastructure Construction	Electrical Infrastructure Construction	Eng
Engineering & Related Design	Engineering & Related Design	Engineering & Related Design	Eng
Mechatronics			Eng
Information Technology & Computer Science	Information Technology & Computer Science	Information Technology & Computer Science	Eng
Finance, Economics and Accounting	Finance, Economics and Accounting	Finance, Economics and Accounting	Sec Com
Management	Management	Management	Sec Com
Marketing	Marketing	Marketing	Management
Office Administration	Office Administration	Office Administration	Sec Com
Primary Agriculture	Primary Agriculture	Primary Agriculture	Agri
Safety in Society	Safety in Society	Safety in Society	Com
Hospitality	Hospitality	Hospitality	Hospitality
Tourism	Tourism	Tourism	Hospitality
Education and Development			Sec Com

Department of Higher Education and Training, 2011

QUESTIONNAIRE FOR FET COLLEGES

The questionnaire targets only engineering studies, skills divisions/faculties and Article 21 businesses associated or corresponding with engineering education. In order to reduce the length of the questions or statements **all the equivalent divisions are classified under and referred to as "engineering studies".**

The aim is to explore the possibility of integrated programmes (practical skills development) as optional education for unindentured (unattached/private) learners that will improve their prospects and enhance their scholastic performance. Determining the relationship between exit-level learners at colleges and the annual number of vacancies matching their courses can reveal a situation which may necessitate additional programmes at FET Colleges. Inevitably, the education, educational capacity and employment prospects of the learners must be investigated. A few aspects that stimulate further interest in the new NC(V) programmes have also recently emerged. A closer look at these may prove fruitful.

Reliable responses to the questions, statements and statistics may reveal valuable information about the quest for more skills development. Feedback will be given to all the participants. A copy of the research results will be made available to all the participating colleges.

Please give actual numbers where requested. Avoid percentages as far as possible.

Further elaboration on any of the questions, statements, statistics and your answers may be done on the additional sheets of paper included in this parcel.

PA PRIVATE (UN INDENTURED) LEARNERS IN ENGINEERING STUDIES AT FET COLLEGES

PA1 What is the average age of new learners (first enrolment) in engineering studies?

PA2 How would you describe the educational capacity of the average engineering studies learner?
Please tick just **one** of the following: ....

Excellent educational performer	5
Above average performer	4
Average educational performer	3
Below average performer	2
Poor educational performer	1
No comment	0

PA3 The average learner in engineering studies takes responsibility for his/her own education. (This doesn't negate the responsibility of the lecturers.) Please tick just **one** of the following:

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PA4 The average learner in engineering studies performs better in hands-on practical training than in the academic component. Please tick just **one** of the following:

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PA5 Workshop practice (hands-on training) enhances their academic performance.
Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PA6 It is easier to maintain discipline in the workshops than in the classrooms.
Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PA7 Learners cooperate better in the workshops than in the classrooms.
Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PA8 Learners tend to work more independently in the workshops than in the classrooms.
Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PA9 How innovative are learners in engineering studies?
Please tick just **one** of the following: ....

Highly	5
Quite	4
Fairly	3
Barely	2
Not at all	1
No remark	0

PA.10 Why do learners prefer to follow engineering courses at FET Colleges to other programmes at other institutions?

PB OPPORTUNITIES FOR UNINDENTURED (PRIVATE) LEARNERS IN ENGINEERING STUDIES

PB1 Your institution makes provision for learners who **do not** qualify for NC(V) courses.
Please tick **one** of the following:

Accommodates all candidates	5
Accommodates learners according to interest	4
Accommodates learners according to interest and aptitude	3
Accommodates only potential achievers	2
Does not make provision for unsuccessful NC(V) candidates	1

PB2 For what category of employment do learners at exit level of skills programmes (2.8) qualify? Please **tick** the relevant box.

Artisan	5
Apprenticeship	4
Learnership	3
Semi-skilled	2
Other Job	1

PB3 For what category of employment do learners with an NC(V) 4 certificate qualify? Please **tick** the relevant box.

Artisan	5
Apprenticeship	4
Learnership	3
Semi-skilled	2
Other Job	1

PB4 Can NC(V) 4 (NQF 4) qualify learners for higher education (university courses)?

Yes	No

PC FET COLLEGE ENGINEERING PROGRAMMES

The following *Likert Scale* applies to the statements:

5	Strongly agree
4	Agree
3	Neither agree nor disagree
2	Disagree
1	Strongly disagree

Pleas **tick** your choice in the relevant box.

PC1	FET Colleges should not cater for private (unindentured) learners in engineering studies.	5	4	3	2	1
PC2	FET Colleges should offer only NC(V) programmes.	5	4	3	2	1
PC3	Every FET College should focus on the needs of local businesses and community.	5	4	3	2	1
PC4	FET Colleges must design and develop their own skills programmes, which address the needs of local businesses and community.	5	4	3	2	1
PC5	The Department of Education must design and develop the skills programmes needed locally.	5	4	3	2	1
PC6	Alternative education for unattached learners already exists.	5	4	3	2	1
PC7	The NC(V) programmes satisfy the needs of local businesses and community.	5	4	3	2	1
PC8	There is no need for additional skills programmes.	5	4	3	2	1
PC9	Skills programmes do not meet with the expectations.	5	4	3	2	1
PC10	The NC(V) programmes do not comply with the expectations.	5	4	3	2	1
PC11	The standard of the NC(V) programmes is too high for the learners.	5	4	3	2	1
PC12	Additional skills programmes are essential because skills development is included in the mission of FET Colleges.	5	4	3	2	1
PC13	Skills programmes should be integrated programmes with separate subjects, e.g. interdisciplinary.	5	4	3	2	1
PC14	Skills programmes should be integrated programmes where subjects are **not** taught separately, e.g. trans-disciplinary.	5	4	3	2	1
PC15	Integration is unnecessary. Learners must discover relationships themselves.	5	4	3	2	1
PC16	FET Colleges should teach only subject knowledge which is directly applicable to the trade (core learning)..	5	4	3	2	1
PC17	It is not a responsibility of FET Colleges to know the personnel needs of the labour market.	5	4	3	2	1
PC18	FET Colleges offer what their "customers" (learners/community) want. ..	5	4	3	2	1
PC19	FET Colleges offer what the Department of Education prescribes.	5	4	3	2	1
PC20	NC(V) programmes are designed to train artisans.	5	4	3	2	1
PC21	Learners should get artisan status after successful completion of NC(V) 4.	5	4	3	2	1
PC22	The hands-on (practical) training of NC(V) programmes is insufficient. ..	5	4	3	2	1

4 APPENDIX G

PD ENTREPRENEURIAL SKILLS

PD1 Entrepreneurial attributes can be acquired through study and experience.

Please **tick** just the relevant box.

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PD2 The entrepreneurial knowledge must be taught as an integral part of the practical programme – no separate subjects: transdisciplinary.

Please tick just **one** of the following: ……………………

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

PD3 What are the characteristics required to become an entrepreneur?

PD4 Please make a list of viable enterprises that unattached (private) learners can venture into after completion of their education.

QUESTIONNAIRE, LEARNERS

This questionnaire forms part of an investigation into the feasibility of integrated practical programmes (hands-on skills development) as additional options for unattached (private) learners in engineering studies.

No form of identification is needed. The information gathered will only be used for the mentioned purpose and you will remain anonymous. Please answer the questions openly and honestly.

LA PRIVATE (UNATTACHED) LEARNERS IN ENGINEERING STUDIES AT FET COLLEGES

LA1 What is the highest school grade (standard) that you did? | Gr 9 | Gr 10 | Gr 11 | Gr 12 |

LA2 How do you learn best? Please select the way of learning that is comparable to your preference.

Watching (demonstration, observation – to see how things are done)	5
Listening (teaching, listening – to hear how things are done)	4
Learning (exercising, repetition and testing yourself)	3
By doing things for yourself (practising, applying observed knowledge)	2
Studying (discover knowledge by yourself – to find out more about lesson topic) .	1

LA3 How do you perform in each of the following activities? Use a 6-point scale (5, 4, 3, 2, 1, 0)
5 = Excellent; 4 = Good; 3 = Acceptable; 2 = Unacceptable; 1 = Poor; 0 = No comment.
Please just **tick** the relevant box in each item.

LA3.1	LReading	5	4	3	2	1	0
LA3.2	Writing	5	4	3	2	1	0
LA3.3	Drawing (Engineering/Technical Drawing)	5	4	3	2	1	0
LA3.4	Explaining school/college homework to a friend ...	5	4	3	2	1	0
LA3.5	Sorting out the operation of mechanisms	5	4	3	2	1	0
LA3.6	Making objects out of wood	5	4	3	2	1	0
LA3.7	Making objects out of metal	5	4	3	2	1	0
LA3.8	Doing mechanical repairs (machines, engines etc.)	5	4	3	2	1	0
LA3.9	Repairing domestic appliances	5	4	3	2	1	0
LA3.10	Understanding electrical, electronic circuit diagrams	5	4	3	2	1	0

LA4 Which are your shortcomings in academic activities (learning)? Use a 6-point scale
5 = Big problem; 4 = Problem; 3 = Fair problem; 2 = Slight problem; 1 = No problem;
0 = No comment: **Please select one value from each of the following items:**

LA4.1 Lack of interest. *Find academic stuff (reading, writing, learning etc.) boring.*
| 5 | 4 | 3 | 2 | 1 | 0 |

LA4.2 Lack of motivation. *Can't find a reason to do the assigned work.* ....
| 5 | 4 | 3 | 2 | 1 | 0 |

LA4.3 Lack of concentration. *Can't keep your mind occupied with the assignment.*
| 5 | 4 | 3 | 2 | 1 | 0 |

LA4.4 Inhibition: e.g. difficulty to get started. *Always find something "more important" to do.*
| 5 | 4 | 3 | 2 | 1 | 0 |

LA4.5 Fear of failure. *Afraid of the consequences of your attempt – excuses keep popping up.*
| 5 | 4 | 3 | 2 | 1 | 0 |

LA4.6 Difficulty in finding relevance/relations. *Can't relate knowledge to facets of the assignment.*
| 5 | 4 | 3 | 2 | 1 | 0 |

LA4.7 Lack of perseverance. *Easily lose interest in a task.*
| 5 | 4 | 3 | 2 | 1 | 0 |

LA5 Education is a shared responsibility. How important is the contribution of each of the partners in your education? ***5 = Extremely, 4 = Very important, 3 = Important, 2 = Slightly important 1 = Very little.*** Please select **one in each** of the following entities **(16.1 to 16.5):**

LA5.1	College: (means, mode and management)	5	4	3	2	1
LA5.2	Lecturers: (execution and facilitation)	5	4	3	2	1
LA5.3	Learners (Students): (teamwork: study, exercise, apply)	5	4	3	2	1
LA5.4	Parents: (financing, support and management)	5	4	3	2	1
LA5.5	Yourself: (study, execution and demonstration of competence)	5	4	3	2	1

LA6 You take responsibility for your own education. (This doesn't negate the responsibility of the lecturers.)
Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

LA7 You perform better in hands-on practical (workshop) training than in classroom activities. Please tick just **one** of the following:

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

LA8 Workshop practice (hands-on training) enhances your academic performance (learning in the classroom).
Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

LA9 It is better in the workshops than in the classrooms.
Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

LA10 You cooperate better with personnel in the workshops than in the classrooms. Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

LA11 You tend to work more independently in the workshops than in the classrooms. Please tick just **one** of the following: ....

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

LA12 All the theory and knowledge must be directly related and applicable to the practical work.
Please tick just **one** of the following:

Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1

LA13 How would you describe your performance at school?
Please just tick **one** of the following: ....

Excellent educational performer	5
Above average performer	4
Average educational performer	3
Below average performer	2
Poor educational performer	1
No comment	0

LA15 How innovative are you?

Highly	5
Quite	4
Fairly	3
Barely	2
Not at all	1
No remark	

ENTREPRENEURSHIP/SELF-EMPLOYMENT OPPORTUNITIES

LD1 Please indicate your chances of beginning your own small business after completion of your course. *(Entrepreneurship)*
Please tick just **one** of the following: ....

Excellent	5
Good	4
Average (50/50)	3
Poor	2
Very poor	1

LD2 Would you like to have your own business after completion of your course?
Please tick just **one** of the following: ....

Very much	5
Much	4
It doesn't matter	3
I don't want a business	2
I'm against having a business	1

OPEN-ENDED QUESTIONS

LA14 Please motivate your choice in A13, educational performance at school:

LA16 Please give reasons why you enrolled in an engineering course at an FET College instead of studying at another institution?

1 APPENDIX I

COLLEGES PARTICIPATING IN THE RESEARCH

▪ Eastern Cape:	Eastern Cape Midlands College for FET
	Ikhala FET
▪ Free Sate:	Flavius Mareka College for FET
	Goldfields College for FET
	Maluti College for FET
	Motheo College for FET
▪ Gauteng:	Sedibeng College for FET
▪ Kwazulu-Natal:	Mthashana FET Institution
	Thekwini College for FET
▪ Limpopo:	Lephalale FET
	Mopani South East FET College
▪ Mpumalanga:	Ehlanzeni FET College
▪ North-West:	Orbit College for FET
	Vuselela FET College
▪ Northern Cape:	Northern Cape Urban College for FET
▪ Western Cape:	College of Cape Town FET

MECHANICAL SKILLS LEVEL 1 INTRODUCTION FOR TECHNICAL EDUCATION

MS 1 WORKSHOP DIVISION – WORKSHOP ORIENTATION MODULE

UNITS	- SUB-UNITS -				
1 WORKSHOP ORIENTATION	1.1 SAFETY EQUIPMENT	1.2 HAND TOOLS	1.3 HAND POWER TOOLS	1.4 WS EQUIPMENT	1.5 METAL MACHINING
	1.1.1 Safety Signs and Markings	1.2.1 Spanners	1.3.1 Drilling Machine	1.4.1 Power Machines	1.5.1 Lathe
	1.1.2 Fire Extinguishing	1.2.2 Wrenches and Pliers	1.3.2 Angle Grinder	1.4.2 Welding Equipment	1.5.2 Milling Machine
	1.1.3 First Aid	1.2.3 Miscellaneous	1.3.3 Sheet Metal Cutter (Nib)	1.4.3 Lifting Equipment	1.5.3 Shaper
2 WORKSHOP LIFTING DEVICES	2.1 OVERHEAD CRANE	2.2 VEHICLE HOIST	2.3 ENGINE HOIST	2.5 TROLLEY JACK	2.6 AIR and BOTTLE JACKS
	2.1.1 Operation	2.2.1 Operation	2.3.1 Operation	2.5.1 Operation	2.6.1 Operation
	2.1.2 Capacity	2.2.2 Capacity	2.3.2 Capacity	2.5.2 Capacity	2.6.2 Capacity
	2.1.3 Safety (OHS)	2.2.3 Safety (OHS)	2.3.3 Safety (OHS)	2.5.3 Safety (OHS)	2.6.3 Safety (OHS)
	2.1.4 Hooking Procedure	2.2.4 Parking Vehicle in Position	2.3.4 Hooking Procedure	2.5.4 Jack Spots on Vehicle	2.6.4 Jack Spots on Vehicle
	2.1.5 Operational Procedure	2.2.5 Operational Procedure	2.3.5 Operational Procedure	2.5.5 Jacking Procedure	2.6.5 Jacking Procedure
	2.1.6 Lifting	2.2.6 Lifting	2.3.6 Lifting	2.5.6 Lifting	2.6.6 Lifting
	2.1.7 Detaching	2.2.7 Lowering the Vehicle	2.3.7 Detaching	2.5.7 Securing the Vehicle	2.6.7 Securing the Vehicle
		2.2.8 Driving Vehicle Off Hoist	2.4 GEARBOX JACK	2.5.8 Lowering the Vehicle	2.6.8 Lowering the Vehicle
3.1 METALWORK EQUIPMENT	3.1.1 METAL CUTTING	3.1.2 METAL SHAPING/FINISH	3.1.3 METAL DRILLING	3.2 WELDING AND FINISHING	
	3.1.1.1 Hacksaw	3.1.2.1 Hand Files	3.1.3.1 Drilling Machine	3.2.1 ARC WELDING	3.2.8 SURFACE FINISHING
3.2 WELDING AND FINISHING	3.1.1.2 Power Hacksaw	3.1.2.2 Scrapers	3.1.3.2 Drill Press	3.2.2 ARC WELD MACHINES	3.2.8.1 Bench Grinder
	3.1.1.3 Guillotine	3.1.2.3 Sheet Metal Shaping	3.1.3.3 Drill Bits	3.2.3 INVERTER WELDER	3.2.8.2 Angle Grinder
	3.1.1.4 Friction Cutter		3.1.3.4 Drill Bit Sharpening	3.2.4 CO_2 ARC WELDER (MIC)	3.2.8.3 Electric Buff
	3.1.1.1.5 Nibbler			3.2.5 TIC WELDER	3.2.8.4 Grinders and Cutters
	3.1.1.6 Oxy-Acetylene Cutting			3.2.6 GAS WELDING	(Stones and Bits)
	3.1.1.7 Plasma Cutting			3.2.7 BRAZING	
	MS 1 METALWORK DIVISION				
MODULE	- UNITS -				
4 METALWORK TASKS	4.1 METAL KNOWLEDGE	4.2 ARC WELDING TASK	4.3 BRAZING TASK	4.4 COMBINATION OF METHODS	
	4.1.1 Identification of Metals	4.2.1 Project Planning	4.3.1 Project Planning	4.4.1 Project Planning	4.4.5.2 Operating Oxy-Acetylene
	4.1.2 Metal Characteristics	4.2.2 Selection of Material	4.3.2 Selection Of Material	4.4.2 Selection of Material	4.4.5.3 Arc Weld Joints
	4.1.3 Metal Alloys	4.2.3 Project, Site Layout	4.3.3 Site Layout, Preparation	4.4.3 Project, Site Layout	4.4.5.4 Braze Specific Joints
	4.1.4 Welding Methods	4.2.4 Make Project Parts	4.3.4 Make Project Parts	4.4.4 Make Project Parts	4.4.5.5 Assembling the Project
		4.2.5 Assembling the Project	4.3.5 Brazing the Joints	4.4.5 Brazing Joints	4.4.6 Finishing and Protection
		4.2.6 Finishing and Protection	4.3.6 Finishing and Protection	4.4.5.1 Welding, Brazing Rods	4.4.6.1 Painting the parts
5 METALWORK PROJECTS	5 PROJECT PROCEDURE				
	5.1 PROJECT PLANNING	5.2 PROCUREMENT	5.3 PROJECT LAYOUT	5.4 ASSEMBLING	
	5.1.1 Planning Schedule	5.2.1 Material Quotations	5.3.1 Site Preparation	5.4.1 Joining the parts	
	5.1.2 Structure Plan and Sketch	5.2.2 Overhead Costs	5.3.2 Selection, Measurements	5.4.1.1 Method Selection	
	5.1.3 Sketches/Drawings	5.2.3 Material Cost Calculations	5.3.3 Making Project Parts	5.4.2 Finishing	
	5.1.4 Dimension Calculations	5.2.4 Time Schedule and Labour Costs	5.3.3.1 Cutting, Drilling, Shaping	5.4.2.1 Shaping, Refining, Polishing	
	5.1.5 Material Calculations	5.2.5 Production Costs, Profit, Price	5.3.4 Project Layout: Construction Plan	5.4.3 Corrosion Protection	
		5.2.6 Material Purchasing			

MS 1 MECHANICAL MAINTENANCE

MODULE	- UNITS -			
6 REPLACE DEFECTIVE COMPONENTS (MOTOR VEHICLES)	6.1 MOTOR VEHICLE LAYOUT	6.2 REPLACE SHOCK ABSORBERS	6.3 WHEELS AND TYRES	6.4 REPLACE DISC PADS
	6.1.1 Component Identification	6.2.1 Site Preparation Select Equipment, Tools	6.3.1 Site Preparation Select Equipment, Tools	6.4.1 Select Equipment, Tools
	6.1.2 Component Functions			6.4.2 Lifting and Securing Vehicle
	6.1.3 Component Mountings	6.2.2 Lifting and Securing Vehicle	6.3.2 Lifting and Securing Vehicle	6.4.3 Remove Wheels
	6.1.4 Locking Devices	6.2.3 Remove Shock Absorbers Shock Construction, Operation	6.3.3 Remove the Wheel(s)	6.4.4 Check System for Defects
	6.1.5 Control Links and Wiring		6.3.4 Inspection, Selection of New Tyres	6.4.5 Replace Brake Pads
		6.2.4 Fit New Shock Absorbers	6.3.5 Mount the Wheel(s)	6.4.6 Mount Wheels
		6.2.5 Lower and Clean Vehicle	6.3.6 Lower and Clean Vehicle	6.4.7 Lower and Clean Vehicle
	6.5 REPLACE EXHAUST SYSTEM	6.6 REPLACE RADIATOR	6.7 REPLACE BATTERY	6.8 REPLACE ALTERNATOR
	6.5.1 Preparation, Hoist, Tools, Equip	6.6.1 Vehicle Preparation	6.7.1 OHS, Acids	6.8.1 Procedure Plan
	6.5.2 Remove Exhaust System	6.6.2 Remove Radiator	6.7.2 Select Tools and Equipment	6.8.2 Dismantling
	6.5.3 Fit New Exhaust System	6.6.3 Mount Radiator, New/Repaired	6.7.3 Remove Battery	6.8.3 Inspection
	6.5.4 Wrapping Up Operations	6.6.4 Wrapping Up Operations	6.7.4 Cleaning	6.8.4 Mounting
			6.7.5, 6.7.6 Inspection	6.8.5 Wrapping Up
			6.7.7 Battery Features	
			6.7.8 Charging Procedure	
			6.7.9 Cleaning Up	
7 REMOVE/REPLACE COMPONENTS (VEHICLES)	7.1 REPLACE STARTER	7.2 ENGINE REMOVAL	7.3 GEARBOX REMOVAL RWD	7.4 Final Drive Removal
	7.1.1 Plan Procedure	7.2.1 Preparation Plan	7.3.1 Preparation Plan	7.4.1 Preparation Plan
	7.1.2 Dismantling	7.2.2 Remove Support Components	7.3.2 Remove Controls and Monitors	7.4.2 Remove Rear Wheels, Parts
	7.1.3 Inspection	7.2.3 Unmount, Remove Engine	7.3.3 Unmount, Remove Gearbox	7.4.3 Remove Centrepiece
	7.1.4 Mounting Starter	7.2.4 Wrapping Up Operations	7.3.4 Wrapping Up Operations	7.4.4 Wrapping Up Operations
	7.1.5 Wrapping Up			
			RWD = Rear Wheel Drive	

MS 1 POWER TRANSMISSION

MODULE	- UNITS -				
8 TRANSMISSION DEVICES	8.1 FLAT BELT DRIVES	8.2 V-BELT DRIVES	8.3 DIRECT COUPLINGS	8.4 ROLLER CHAIN DRIVES	8.5 SIMPLE GEAR DRIVES
	8.1.1 Composition	8.2.1 Composition	8.3.1 Solid Couplings	8.4.1 Composition	8.5.1 Composition
	8.1.2 Features	8.2.2 Features	8.3.2 Flexible Couplings	8.4.2 Construction	8.5.2 Construction
	8.1.3 Dynamics	8.2.3 Dynamics	8.3.3 Alignment	8.4.3 Features	8.5.3 Features
	8.1.4 Belt Construction	8.2.4 Belt Construction	8.3.4 Maintenance	8.4.4 Dynamics	8.5.4 Dynamics
	8.1.5 Maintenance	8.1.5 Maintenance		8.4.5 Maintenance	8.5.5 Maintenance

MS 2 WORKSHOP DIVISION

UNITS	- SUB-UNITS -			
1 SPECIAL TOOLS AND CARE	1.1 TORQUE WRENCH	1.2 TORQUE PROTRACTOR	1.3 STUD REMOVER	
	1.1.1 Construction	1.2.1 Construction	1.3.1 Construction	
	1.1.2 Operation	1.2.2 Function	1.3.2 Function	
	1.1.3 Care	1.2.3 Operation	1.3.3 Operation	
		1.2.4 Care	1.3.4 Care	
2 PRECISION MEASURING INSTRUMENTS	2.1 VERNIER CALLIPER	2.2 DIAL GAUGE	2.3 MICROMETER, OUTSIDE	2.4 MICROMETER, INSIDE
	2.1.1 Construction	2.2.1 Composition	2.3.1 Composition	2.4.1 Composition
	2.1.2 Function	2.2.2 Function	2.3.2 Function	2.4.2 Function
	2.1.3 Operation	2.2.3 Operation	2.3.3 Operation	2.4.3 Operation
	2.1.4 Measurements	2.2.4 Measurements	2.3.4 Measurements	2.4.4 Measurements
	2.1.5 Care	2.2.5 Care	2.3.5 Care	2.4.5 Care

MS 2 METAL MACHINING

MODULE	- UNITS -		
3 METAL TURNING AND SHAPING INTRODUCTION	3.1 SHAPING MACHINE	3.2 LATHE	3.3 MILLING MACHINE
	3.1.1 Function, Construction, Operation	3.2.1 Function, Construction, Operation	3.3.1 Function, Construction, Operation
	3.1.2 Variety of Applications	3.2.2 Simple Turning Task	3.3.2 Keyway Cutting
	3.1.3 Metal Surface Shaping	3.2.3 Turning to Specific Sizes	3.3.3 Surface Cutting/Facing
	3.1.4 Keyway Cutting	3.2.4 Run-out Test on Disc - Dial Gauge	3.3.4 Surface Finishing
	3.1.5 Cleaning Up	3.2.5 Cleaning Up	3.3.5 Cleaning Up

MS 2 MECHANICAL MAINTENANCE

MODULE	- UNITS -			
4 COOLING SYSTEM MAINTENANCE	4.1 REPLACE ELECTRIC FAN	4.2 BELT DRIVEN COOLING FAN	4.3 REPLACE THERMOSTAT	4.4 REPLACE WATER PUMP
	4.1.1 Cooling System Operation	4.2.1 Viscous Fan Drive	4.3.1 Preparation, Procedure, Tools	4.4.1 Preparation
	4.1.2 Electric Fan Operation	4.2.2 Cooling Fan Characteristics	4.3.2 Thermostat Features	4.4.2 Water Pump Features
	4.1.2 Test Thermo Switch Operation	4.2.3 Replace Viscous Fan	4.3.3 Replace Thermostat	4.4.3 Replace Water Pump
	4.1.3 Replace Electric Fan	4.2.4 Wrapping Up Operations	4.3.4 Wrapping Up Operations	4.4.4 Wrapping Up Operations
	4.1.4 Wrapping Up Operations			

MODULE	- UNITS -				
5 INTRODUCTION TO MOTOR	5.1 MCPHERSON STRUTS	5.2 REMOVE GEARBOX*	5.3 MOUNT GEARBOX	5.4 MOUNT ENGINE	5.5 MOUNT FINAL DRIVE*
VEHICLE REPAIRS	5.1.1 Preparation	5.2.1 Preparation	5.3.1 Vehicle Preparation	5.4.1 Vehicle Preparation	5.5.1 Preparation
	5.1.2 Dismantling Procedure	5.2.2 Remove Controls, Monitors	5.3.2 Mount Gearbox	5.4.2 Mounting Engine	5.5.4 Mounting Final Drive
	5.1.3 Assembling Procedure	5.2.3 Unmount, Remove Gearbox	5.3.3 Attach Controls, Monitors	5.4.3 Replace Support Components	5.5.5 Assembling Rear Axle Unit
	5.1.4 Wrapping Up	5.2.4 Wrapping Up Operations	5.3.4 Wrapping Up Operations	5.4.4 Wrapping Up Operations	5.5.7 Wrapping Up
		*Front Wheel Drive			*Front Engine, Rear W Drive

6 MOTOR VEHICLE MAINTENANCE	6.1 LUBRICATION SERVICE			6.2 BATTERY MAINTENANCE
(INTRODUCTION)	Engine Lubrication	Components, Cooling System, Latches	Inspection and Report	6.2.1 Procedure, OHS
	6.1.1 Site Preparation	6.1.8 Lubricant and Liquid Levels	6.1.14 Air and Fuel Filters	6.2.2 Basic Battery Structure
	6.1.2 Procedure	6.1.9 Wearing Surfaces Lubrication	6.1.15 Liquid Leaks	6.2.3 Cleaning Battery
	6.1.3 Tools Selection	6.1.10 Coolant Quality and Level	6.1.16 Shock Absorbers	6.2.4 External Inspection
	6.1.4 Lubrication, Oil Contamination	6.1.11 Cooling Components	6.1.17 Driving Shafts	6.2.5 Internal Inspection
	6.1.5 Filters	6.1.12 Belt Drives	6.1.18 Tyres	6.2.6 Battery Features
	6.1.6 Oil Qualities, Selection, Quantities	6.1.13 Battery Care (6.2)	6.1.19 Lights	6.2.7 Charging Procedure
	6.1.7 Refill Procedure		6.1.20 Cleaning Up	6.2.8 Cleaning Up

7 INTRODUCTION INTO	7.1 ENGINE DISMANTLING, PARTS	7.2 ENGINE OPERATION, SI AND CI		
MOTOR VEHICLE TECHNOLOGY	7.1.1 Site Preparation	7.2.2 SI Operating Cycle, Four Stroke	7.2.3 CI Operating Cycle, Four Stroke	7.2.3.10 Efficiency
	7.1.2 Engine Preparation	7.2.2.1 Gas Pressure	7.2.3.1 Gas Pressure vs. Temperature	7.2.3.11 Force, Moments, Power
	7.1.3 Dismantling Procedure	7.2.2.2 Gas Laws (Boyle)	7.2.3.2 Heat, Temperature and Energy	
	7.1.4 Tools and Equipment	7.2.2.3 Energy	7.2.3.3 Pressure Changes During Cycle	7.2.4 Two Stroke Cycles
	7.1.5 Main Components/Parts	7.2.2.4 Pressure, Temperature Changes	7.2.3.4 Ignition	7.2.4.1 SI Valveless
	7.1.6 Parts, Construction, Material	7.2.2.5 Ignition Basics and Effects	7.2.3.5 Combustion	7.2.4.2 SI with Inlet Valves
	7.1.7 Function, Features	7.2.2.6 Combustion, Energy Conversion	7.2.3.6 Speed Control	7.2.4.3 CI GM
		7.2.2.7 Speed Control	7.2.3.7 Ignition vs. Engine Speed	7.2.4.4 Super Charging Basics
		7.2.2.8 Ignition vs. Engine Speed	7.2.3.8 Basic Performance Factors	7.2.4.5 Turbo Charging Basics
		7.2.2.9 Basic Performance Factors	7.2.3.9 Energy Losses	

MS 2 POWER TRANSMISSION

MODULE	- UNITS -			
8 TRANSMISSION DEVICES	8.1 DOUBLE REDUCTION V-BELT	8.2 DOUBLE REDUCTION CHAIN	8.3 GEAR TYPES, ARRANGEMENT	8.4 GEAR DRIVE TRAINS
	8.1.1 Composition	8.2.1 Arrangement	8.3.1 Arrangement	8.4.1 Arrangement
	8.1.2 Features	8.2.2 Construction	8.3.2 Features	8.4.2 Features
	8.1.3 Ratios	8.2.3 Features	8.3.3 Dynamics	8.4.3 Dynamics
	8.1.4 Belt Tensions, Torque, Power	8.2.4 Dynamics	8.3.4 Maintenance	
Friction = Force × Coefficient of Friction	8.1.5 Determining Factors (Friction)	8.2.5 Maintenance		
	8.1.6 Maintenance			

MECHANICAL SKILLS LEVEL 3 MICRO ENTREPRENEURSHIPS AND LOWER LEVEL SKILLS

MS 3 MICRO ENTREPRENEURSHIP

MODULE	- UNITS -					
1 ENTREPRENEURSHIPS	1.1 PERSONAL QUALITIES	1.2 ENVIRONMENT	1.3 KNOWLEDGE, SKILLS	1.4 MANAGEMENT	1.5 MICRO MARKETING	1.6 OPPORTUNITY HUNT
	1.1.1 Predisposition	1.2.1 SA, Local Economy	1.3.1 Business Basics	1.4.1 Business Plan	1.5.1 Local Market Survey	1.6.1 Business Opportunities
	1.1.2 Orientation	1.2.2 Business Environment	1.3.2 Entrepreneurship	1.4.2 Business Setup	1.5.2 Community Needs	1.6.2 Market Gaps
MBE = Micro Business	1.1.3 Personality Traits	1.2.3 MBE Environment	1.3.3 Finances, Bookkeeping	1.4.3 Production Procedure	1.5.3 Customer Care	1.6.3 Community Needs
Enterprise	1.1.4 Social Attributes	1.2.4 Target population	1.3.4 Procurement	1.4.4 Quality Assurance	1.5.4 Advertisement	1.6.4 Business Needs (Trade and Industry)
	1.1.5 Personal Virtues	1.2.5 Support Base	1.3.5 Profit	1.4.5 Customer Feedback	1.5.5 Door-to-Door	
				1.4.6 Interaction - Peers		

MS 3 METALWORK PROPOSITIONS (ENTREPRENEURS)

MODULE	- UNITS -			
2 METALWORK	2.1 BURGLAR PROOFING, FENCING	2.2 GARDEN FURNITURE, FEATURES	2.3 BARBECUE and EQUIPMENT	2.4 EQUIPMENT and APPLIANCES
	2.1.1 Project Planning	2.2.1 Market Survey - Demand	2.2.1 Market Survey - Demand	2.2.1 Market Survey - Demand
	2.1.2 Quotation for Services Offered	2.2.2 Project Planning	2.2.2 Project Planning	2.2.2 Project Planning
	2.1.3 Project Construction	2.2.3 Cost and Price Determination	2.2.3 Cost and Price Determination	2.2.3 Cost and Price Determination
	2.1.4 Assembly/Mounting/Finishing	2.2.4 Project Construction	2.2.4 Project Construction	2.2.4 Project Construction
	2.1.5 Invoicing and Money Collection	2.2.5 Marketing	2.2.5 Marketing	2.2.5 Marketing

MS 3 MECHANICAL MAINTENANCE (ENTREPRENEURS)

MODULE	- UNITS -					
3 MECHANICAL	3.1 SHOCK ABSORBERS	3.2 EXHAUST SYSTEMS	3.3 LUBRICATION	3.4 BATTERY SERVICE	3.5 ENGINE REPLACE	3.6 GEARBOX REPLACE
MAINTENANCES	3.1.1 Market Investigation	3.2.1 Market Investigation	3.3.1 Market Investigation	3.4.1 Market Investigation	3.5.1 Market Investigation	3.6.1 Market Investigation
	3.1.2 Cost, Price Calculations	3.2.2 Cost, Price Calculations	3.3.2 Cost, Price Calculations	3.4.2 Cost, Price Calculations	3.5.2 Cost, Price Calculations	3.6.2 Cost, Price Calculations
	3.1.3 Quotation	3.2.3 Quotation	3.3.3 Quotation	3.4.3 Quotation	3.5.3 Quotation	3.6.3 Quotation
	3.1.4 Execution	3.2.4 Execution	3.3.4 Lubrication Service	3.4.4 Execution	3.5.4 Execution	3.6.4 Execution
	3.1.5 Marketing	3.2.5 Marketing	3.3.5 Marketing	3.4.5 Marketing	3.5.5 Marketing	3.6.5 Marketing
	3.1.6 Invoicing, Collection	3.2.6 Invoicing, Collection	3.3.6 Invoicing, Collection	3.4.6 Invoicing, Collection	3.5.6 Invoicing, Collection	3.6.6 Invoicing, Collection

MS 3 MECHANICAL MAINTENANCE (LOWER LEVEL SKILLS)

MODULE	- UNITS -			
4 MECHANICAL MAINTENANCES	4.1 ENGINE REPLACEMENT	4.2 GEARBOX REPLACEMENT	4.3 ENGINE DISMANTLING	4.4 ASSEMBLY PREPARATION
	4.1.1 Preparation Plan	4.2.1 Preparation Plan	4.3.1 Preparation and Plan	4.4.1 Procedure Plan
	4.1.2 Remove Engine	4.2.2 Remove Gearbox	4.3.2 Dismantling Procedure	4.4.2 Parts Preparation
	4.1.3 Mount Engine	4.2.3 Mount Gearbox	4.3.3 Dismantling Cylinder Head	4.4.3 Artisan Assistance
	4.1.4 Engine Preparation	4.2.4 Wrapping Up	4.3.4 Wrapping Up Procedure	4.4.4 Wrapping Up
	4.1.5 Wrapping Up			

MECHANICAL SKILLS 1
MS1 - 1 WORKSHOP ORIENTATION

February 2011

Unit Standard Outcomes:	Learners can identify tools, know their basic properties and accordingly select suitable material for the specific purpose. Learners can select the correct tools for the specific job and handle them correctly and safely. Learners can select the correct equipment for the specific job and handle it correctly and safely. Learners can motivate their choices verbally and in writing using grammatically correct language and spelling.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate the required skills by calculated execution of assignments through correctly performing procedures and techniques.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: Language: speak, read and write. Measurements: millimetres, centimetres, meters. Fractions.

Learner Activities: Active participation: list tools, equipment - function, use, operation. Reflect verbally, write a report on information and proceedings.

Presentation Policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

1.1 SAFETY EQUIPMENT, GENERAL	1.2 HAND TOOLS	1.3 HAND POWER TOOLS	1.4 WS EQUIPMENT	1.5 METAL MACHINING
1.1.1 Safety Signs and Markings	1.2.1 Spanners, Metric, SAE, Whitworth	1.3.1 Electricity, Volt, Amp, Resistance	1.4.1 Power Machines	1.5.1 Lathe
1.1.1.1 OHS	1.2.2 Socket Sets Metric, SAE, WW	1.3.1 Drilling Machine	1.4.1.1 Battery Charger	1.5.1.1 OHS
1.1.1.2 Personal Safety	1.2.3 Wrenches	1.3.1.1 Safety and Inspection	1.4.1.2 Friction Cutter	1.5.1.2 Function and Operation
1.1.1.3 Workshop and General	1.2.4 Pliers	1.3.1.2 Drill Bits, Types, Material	1.4.1.3 Bench Grinder	1.5.1.3 Equipment
1.1.2 Fire Extinguishing	1.2.5 Hammers	1.3.2 Angle Grinder	1.4.2 Welding Equipment	1.5.1.4 Tools
1.1.2.1 Types of Fire	1.2.6 Keys, Allan, Hexagonal, Spline, Star	1.3.2.1 Safety and Inspection	1.4.3 Lifting Equipment	1.5.2 Milling Machine
1.1.2.2 Prevention	1.2.7 Compasses, Dividers	1.3.2.2 Disc Types - Specific Material	1.4.3.1 Trolley Jack	1.5.2.1 OHS
1.1.2.3 Extinguishing Method	1.2.8 Punches	1.3.3 Sheet metal cutter (Nibbler)	1.4.3.2 Gearbox Jack	1.5.2.2 Function and Operation
1.1.3 First Aid	1.2.9 Engine Tools	1.3.3.1 Safety and Inspection	1.4.3.3 Engine Hoist	1.5.2.3 Equipment
	1.2.10 Miscellaneous	1.3.3.2 Specifications, e.g. thickness	1.4.3.4 Vehicle Hoist	1.5.2.4 Cutters
	1.2.11 Measuring Instruments, e.g. rulers	1.3.3.3 Procedure, Methods	1.4.4.5 Overhead Crane	1.5.3 Shaper

KNOWLEDGE: OHS. Electricity, Basic Circuits and Wiring, Basic Calculations. Tools, Purposes, Procedures. Equipment, Purposes, Operation. General workshop practice.

SKILLS: Select tools and equipment for specific purpose, operate equipment and handle tools safely and correctly.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA:	Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate. Continuous observation and recording of learner participation and performance. Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks. Summative assessment to verify accomplishment of outcomes and execution of tasks. Verify comprehension, competence and knowledge retention. Determine significance of the learning content to the learners. Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Language; dimensions; electricity; arithmetic; leverage; torque.

MS1 - 2 WORKSHOP LIFTING DEVICES

February 2011

Unit Standard Outcomes:	Learner can identify and operate individual lifting devices according to procedure and OHS. Learners can determine load magnitude and compare it with device capacity. Learners can determine cable/chain strength, calculate tensions in the different sections and determine the tensions graphically. Learners can motivate their choices verbally and in writing using grammatically correct language and spelling.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate the required skills by calculated execution of assignments through correctly performing procedures and techniques.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others. Collect, analyse, organise and critically evaluate information.

Knowledge foundation: OHS. Language: Speak, read and write. Science, Technology, Mechanics and Mathematics.

Learner Activities: Active participation, operate device. Calculate the tensions in the cable/chain. Reflect verbally, Write a report on information and proceedings.

Presentation policy: Learners learn by doing - Learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist Education - Learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

2.1 OVERHEAD CRANE	2.2 VEHICLE HOIST	2.3 ENGINE HOIST	2.4 GEARBOX JACK	2.5 TROLLEY JACK	2.6 AIR and BOTTLE JACKS
2.1.1 Operation	2.2.1 Operation	2.3.1 Operation	2.4.1 Operation	2.5.1 Operation	2.6.1 Operation
2.1.2 Capacity	2.2.2 Capacity, Track width	2.3.2 Capacity, Supports, Forces	2.4.2 Capacity and Load	2.5.2 Capacity, Load, Movement	2.6.2 Capacity, Load, Movement
2.1.3 Safety (OHS)	2.2.3 Safety (OHS)	2.3.2.1 Magnitude, Equilibrium	2.4.3 Safety (OHS)	2.5.3 Safety (OHS)	2.6.3 Safety (OHS)
2.1.4 Hooking Procedure	2.2.4 Secure Vehicle in Position	2.3.3 Safety (OHS)	2.4.4 Hooking Procedure	2.5.4 Jack Spots on Vehicle	2.6.4 Jack Spots on Vehicle
2.1.5 Sling Strength and Tensions	2.2.5 Operational Procedure	2.3.4 Hooking Procedure	2.4.5 Operational Procedure	2.5.5 Jacking Procedure	2.6.5 Jacking Procedure
2.1.5 Operational Procedure	2.2.6 Lifting	2.3.5 Operational Procedure	2.4.6 Lifting	2.5.6 Lifting	2.6.6 Lifting
2.1.6 Lifting	2.2.7 Lowering the Vehicle	2.3.6 Lifting	2.4.7 Lowering	2.5.7 Securing the Vehicle	2.6.7 Securing the Vehicle
2.1.7 Detaching	2.2.8 Driving Vehicle Off Hoist	2.3.7 Lowering		2.5.8 Lowering the Vehicle	2.6.8 Lowering the Vehicle
		2.3.8 Detaching			

KNOWLEDGE: OHS (no people in vehicle, near hoist etc.) Purpose, operation. Secure vehicle/object. Determine cable/chain strength. Calculate tension in cable/chain. Determine tensions graphically. Demonstrate comprehension of movement, direction of movement, angles, tolerances, provision for movement and direction, magnitude of forces, reaction forces in supports and equilibrium.

SKILLS: Operate equipment safely and correctly according to procedure. Secure vehicle/object.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Value property and equipment.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1 Workshop Orientation, Forces, Moments, Tensile Strength, Trigonometry

MS1 - 3.1 METAL WORK EQUIPMENT

February 2011

Unit Standard Outcomes	Learner can operate individual metal cutting devices according to procedure and OHS. Learners can determine device cutting capacity and select appropriate method according to material properties. Learners can operate the cutting equipment safely and precisely. Learners can explain the chemical composition of the gasses and gas cutting chemical reaction. Learners can motivate their choices verbally and in writing using grammatically correct language and spelling.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: OHS. Language: speak, read and write. Science, Technology, Mechanics and Mathematics. Measurements, length, thickness, angles and instruments.

Learner Activities: Active participation: operate devices. Perform different cuts on different metal profiles. Reflect verbally, write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - Learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

3.1.1 METAL CUTTING				3.1.2 METAL SHAPING/FINISHING
3.1.1.1 Hacksaw	3.1.1.2.4 Cutting Procedure	3.1.1.4.2 Operation, Precautions	**3.1.1.6** Oxy-Acetylene Cutting (Oxidation)	3.1.2.1 Hand Files, Types,
3.1.1.1.1 Blade Fitting	**3.1.1.3** Guillotine	3.1.1.4.3 Disc Types, Metal Profiles	3.1.1.6.1 OHS, Procedures, Precautions	3.1.2.2 Scrapers
3.1.1.1.2 Metal Cutting, Method	3.1.1.3.1 OHS, Safety, Precautions	3.1.1.4.4 Select Cutting Disc	3.1.1.6.2 Protective Gear	3.1.2.3 Sheet Metal Shaping
3.1.1.1.3 Blade Classification, Purpose	3.1.1.3.2 Operation, Cutting Thickness	3.1.1.4.5 Cutting Procedure	3.1.1.6.3 Gas and Gas Plant Features	3.1.3 METAL DRILLING
3.1.1.1.4 Metal, Blade Selection,	3.1.1.3.3 Sheet Metal Cutting	**3.1.1.5** Nibbler (Shears and Punch)	3.1.1.6.4 Procedure, Adjustment, Cutting	3.1.3.1 Drilling Machine
3.1.1.2 Power Hacksaw	3.1.1.3.4 Metal Profiles, Capacity	3.1.1.5.1 OHS, Protective Gear	**3.1.1.7** Plasma Cutting	3.1.3.2 Drill Press
3.1.1.2.1 OHS, Safety, Precautions	3.1.1.3.5 Cutting Procedure	3.1.1.5.2 Operation, Metal Thickness	3.1.1.7.1 OHS, Procedures, Precautions	3.1.3.3 Drill Bits
3.1.1.2.2 Operation	**3.1.1.4** Friction Cutter	3.1.1.5.2 Cutting Procedure, Limitations	3.1.1.7.2 Process and Limitations	3.1.3.4 Drill Bit Sharpening
3.1.1.2.3 Blade Selection	3.1.1.4.1 OHS, Protective Gear		3.1.1.7.3 Procedure	3.1.3.5 Procedure

KNOWLEDGE: OHS. Metal cutting equipment. Selection of procedure and equipment according to the material. Acetylene properties, chemical composition, oxygen. Gas cutting process (chemistry). Plasma cutting chemistry, procedure and limitations. Precautions and safety gear.

SKILLS: Operate equipment safely and correctly according to procedure. Cut metal to size accurately and neatly using appropriate methods.

VALUES: Communication etiquette, respect for, empathy with peers, honesty and dedication. Meticulous execution of tasks. Personal and people safety. Value tools and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1 Workshop orientation: Electricity, 1.2 Tools, 1.2.11 Instruments, 1.3 Power Hand Tools.

MS1 - 3.2 WELDING AND FINISHING

February 2011

Unit Standard Outcomes:	Learner can select and explain individual welding machines, principles, procedure and OHS. Identify appropriate protective clothing and equipment. Learners can weld pieces of metal demonstrating different types of joint and joint durability. Learners can explain AC and DC, distinguish between AC and DC machines and explain the advantages and disadvantages of each. Learners can motivate their choices verbally and in writing using grammatically correct language and spelling. Sketch simple related wiring diagrams.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: OHS. MS1-1.3 Hand Power Tools. MS1-1.4.2 Welders. MS1-3.1.1.6 Oxy-Acetylene Set. Language: speak, read and write. Science, Technology, Mechanics and Mathematics.

Learner Activities: Active participation: Welding with the different machines and equipment. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

3.2.1 ARC WELDING	3.2.2 ARC WELDING MACHINES		3.2.3 INVERTER WELDER	3.2.6.1 Procedure
3.2.1.1 Arc Welding Machine	3.2.2.1 AC Welders, Operation	3.2.2.8 Protective Clothing, Equipment	3.2.3.1 Inverting AC to DC Transformer	3.2.6.2 Filler Material
3.2.1.2 Electricity, Volt, Amp, Resistance	3.2.2.2 Features of AC Welders	3.2.2.9 Welding Procedure, Techniques	3.2.3.2 Arc Welding Procedure	3.2.6.3 Features
3.2.1.3 Electron Flow, Bridging a Gap	3.2.2.3 DC Welders, Operation	Arc: Length, Intensity, Radiation, Light	3.2.4 CO_2 ARC WELDER (MIC)	3.2.7 BRAZING
3.2.1.4 Resistance, Heat, Power	3.2.2.4 Features of DC Welders	Puddle, Rod Angle, Movement	3.2.4.1 Shielding Gas, Welding Procedure	3.2.7.1 Procedure
3.2.1.5 Direction of Electron Flow, Heat,	3.2.2.5 Current and Heat, Adjustment,	Flux, Metal Flow, Shielding Gas	3.2.5 TIC WELDER (Non-Consumable Stick)	3.2.7.2 Flux, Filler Material
Temperature and Effects on Joint	Joint, Material, Electrode	Avoiding Flux inclusion in Joint	3.2.5.1 Shielding Gas	3.2.7.3 Features
3.2.1.6 Heat, Expansion, Coefficient of	3.2.2.6 Current, Electrode, Penetration	Type of Joint, Techniques, Gravity on	3.2.5.2 Additional Filler Material	3.2.8 JOINT, SURFACE FINISHING
in different materials. Heat Transfer	3.2.2.7 DC: Polarity, Reversed Polarity	Molten Steel - Vertical, Upside Down	3.2.6 GAS WELDING (Oxy-Acetylene)	3.2.8.1 Finishing, protection

KNOWLEDGE: OHS. Electricity, volt, ampere, resistance. Conversion of electric energy into heat energy. Electron flow and heat/temperature difference between positive and negative sides of an air gap. Welding equipment, tools, material and protective gear. Material characteristics, shielding gasses, flux, filler material. Joint preparation, welding methods and techniques. Gas welding plants, procedures, precautions and flame types appropriate for different processes.

SKILLS: Operate equipment safely and correctly according to procedure. Execute welding procedures and techniques resulting in strong joints. Test joints by breaking them.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA:

Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Chemical composition of gasses for welding, dangers and potential chemical reactions. Acetylene = carbide gas. Alternative gasses, comparison of energy values, role of carbon.

MS1 - 4.1 METAL KNOWLEDGE

Unit Standard Outcomes: Learner can identify metals, know their basic properties and accordingly select suitable material for the specific purpose.
Learners can explain how heat is generated in grinding metal, heat conduction and heat capacity and the effects of cooling.
Learners can select the correct joining method, techniques, material and aids.
Learners can motivate their choices verbally and in writing using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate capacity to perform the mathematical and scientific procedures involved in the projects.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Use science and technology effectively and critically, showing responsibility towards the environment and the health of others.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: Safety (OHS), MS1-3.2 Metal Cutting, Shaping, MS1-3.3 Drilling, MS1-3.4 Welding, Bench Grinder, Basics of Welding Methods, Arithmetic, Language

Learner Activities: Active participation, take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

4.1.1 IDENTIFICATION OF METALS	4.1.2 METAL PROPERTIES	4.1.3 CLASSIFICATION	4.1.4 METAL ALLOYS	4.1.5 WELDING METHODS
4.1.1.1 Colour: Basic Colours of Metals	4.1.2.1 Tensile Strength	4.1.3.1 Ferrous Metals	4.1.4.1 Steel Alloys	4.1.5.1 Arc Welding (Stick)
4.1.1.2 Mass of Metals	4.1.2.2 Shear Strength	4.1.3.2 Non-Ferrous	Metals Adding Properties to Steel	4.1.5.2 CO_2 Arc Welding (MIC)
4.1.1.3 Sound Test	4.1.2.3 Compressive Strength	4.1.2.8 Brittleness	4.1.4.2 Copper Alloys	4.1.5.3 TIC Welding (Plasma)
4.1.1.4 Crack Testing	4.1.2.4 Elasticity	4.1.2.9 Hardness	Metals Adding Properties to Copper	4.1.5.4 Gas Welding
4.1.1.5 File Test: Colour, Hardness	4.1.2.5 Ductility	4.1.2.10 Machinability	4.1.4.3 Aluminium Alloys	4.1.5.5 Brazing
4.1.1.6 Centre Punch Test: Hardness	4.1.2.6 Malleability	4.1.2.11 Corrosion Resistant	Metals Adding Properties to	4.1.5.6 Silver Soldering
4.1.1.7 Spark Test: Colour, Features	4.1.2.7 Toughness	4.1.2.12 Heat, Electrical Conductivity	4.1.4.4 Cast Iron, Wrought Iron	4.1.5.7 Lead Soldering

KNOWLEDGE: Metal characteristics. File test reveal colour, hardness and toughness. Weight, force, mass and gravity. Metal temperature and colour. Welding methods and techniques for specific metals. Reasons for alloying metals. Tools, functions, procedure of testing metals. Light and colour relationship: reflection, absorption.

SKILLS: Identify metals, select metal for specific purpose. Select joining/welding method, filler material. Execution of the tests.

VALUES: Communication etiquette, respect for and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Crystal structures of metal. Metal temperature and colour. Effect of quenching on different metals. Light and colour relationship.

Unit Standard Outcomes:	Learners can plan projects, compile a construction plan, make sketches, drawings and execution procedure according to OHS. Learners can do all the calculations involved accurately. Learners can make the different parts of the project, utilising cutting, drilling and shaping and demonstrate the ability to apply integrated knowledge. Learners can weld the different parts together meticulously and join the components into a usable piece of equipment. Learners can motivate their choices and calculations verbally and in writing using grammatically correct language and spelling.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Organise and manage themselves and their activities responsibly and effectively. Identify and solve problems and make decisions using critical and creative thinking. Explore education and career opportunities.

Knowledge Foundation: OHS. Language: speak, read and write. Science, Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metal work.

Learner Activities: Active participation, execute the manual labour, calculations. reflect verbally, write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

4.2.1 PROJECT PLANNING	4.2.3 PROJECT, SITE LAYOUT	4.2.5 ASSEMBLING THE PROJECT	4.2.6 FINISHING AND PROTECTION
4.2.1.1 Planning and Construction Schedule	4.2.3.1 Method of Cutting, Shaping, Trimming	4.2.5.1 Project Layout: Construction Plan	4.2.6.1 Trimming Welding, Sharp Edges, Splinters
4.2.1.2 Structure Plan and Sketch	4.2.3.2 Welding Method, Machine	4.2.5.2 Comply with OHS	4.2.6.2 Check Operation, Functionality
4.2.1.3 Dimensions, Operational Calculations	4.2.3.3 Equipment, Tools Required, Work Space	4.2.5.3 Welding - Different Joints	4.2.6.3 Refining, Polishing, Paint Preparation
4.2.1.4 Material, Accessories Calculations	4.2.3.4 Basic Equipment (Table, Vice)	4.2.5.4 Welding Rod Selection - Type, Thickness	4.2.6.4 Corrosion Protection - Paint, OHS
4.2.2 SELECTION OF MATERIAL	4.2.4 MAKE PROJECT PARTS	4.2.5.5 Current Adjustment - Material, Welding Rod	
4.2.2.1 Metal Selection, Durability, Corrosion	4.2.4.1 Cutting	4.2.5.6 Methods to Counter Expansion, Contraction	
4.2.2.2 Profile, Hardness, Toughness	4.2.4.2 Drilling	4.2.5.7 Corrections for Expansion and Contraction	
4.2.2.3 Purpose, Use	4.2.4.3 Shaping (Bending, Twisting, Grinding)		

KNOWLEDGE: OHS. Electricity, arc welding process, selection of method, application of techniques, metal cutting, shaping, finishing, welding and corrosion protection. Plan a project, select material and develop a construction plan.

SKILLS: Operate equipment safely and correctly according to procedure. Execute arc welding procedures and techniques resulting in strong joints. Spray painting.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-1.3 Hand Power Tools. MS1-1.4.2 Welders, MS1-3.1.1.6 Oxy-Acetylene Set Welding equipment, tools, material and protective gear. Material characteristics, shielding gasses, flux, filler material. Joint preparation, welding methods and techniques. Gas welding plants, procedures, precautions and flame types appropriate for different processes.

MS1 - 4.3 BRAZING PROJECT

February 2011

Unit Standard Outcomes: Learners can plan projects, compile a construction plan, make sketches, drawings and execution procedure according to OHS.
Learners can do all the calculations involved accurately.
Learners can make the different parts of the project, utilising cutting, drilling and shaping and demonstrate the ability to apply integrated knowledge.
Learners can weld the different parts together meticulously and join the components into a usable piece of equipment.
Learners can motivate their choices and calculations verbally and in writing using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Organise and manage themselves and their activities responsibly and effectively.
Identify and solve problems and make decisions using critical and creative thinking.
Explore education and career opportunities.

Knowledge Foundation: OHS. Language: speak, read and write. Science, Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metal work.

Learner Activities: Active participation: execute the manual labour, calculations. Reflect verbally, write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

4.2.1 PROJECT PLANNING	4.2.3 SITE LAYOUT AND PREPARATION	4.2.5 BRAZING THE JOINTS	4.2.6 FINISHING AND PROTECTION
4.2.1.1 Planning and Welding Schedule	4.2.3.1 Method of Cutting, Shaping, Trimming	4.2.5.1 Brazing Rod Selection - Type, Thickness, Flux	4.2.6.1 Trimming Welding, Sharp Edges, Splinters
4.2.1.2 Structure Plan and Sketch	4.2.3.2 OHS, Oxy-Acetylene Plant Preparation	4.2.5.2 Operating Oxy-Acetylene Plant	4.2.6.2 Check Operation, Functionality
4.2.1.3 Dimensions, Operational Calculations	4.2.3.3 Equipment, Tools Required, Work Space	4.2.5.3 Adjust Gas Pressure Regulators	4.2.6.3 Refining, Polishing, Paint Preparation
4.2.1.4 Material, Accessories Calculations	4.2.3.4 Brazing Rods, Flux, Method	4.2.5.4 Welding Procedure	4.2.6.4 Corrosion Protection - Paint, OHS
4.2.2 SELECTION OF MATERIAL	4.2.4 MAKE PROJECT PARTS	4.2.5.5 Comply with OHS	
4.2.2.1 Metal Selection, Durability, Corrosion	4.2.4.1 Cutting	4.2.5.6 Cooling of Brazed Joints - Coefficients of Expansion	
4.2.2.2 Compatibility with Brazing	4.2.4.2 Drilling		
4.2.2.3 Purpose, Use	4.2.4.3 Shaping (Bending, Twisting, Grinding)		

KNOWLEDGE: OHS. Electricity, arc welding process, selection of method, application of techniques, metal cutting, shaping, finishing, welding and corrosion protection. Plan a project, select material and develop a construction plan.

SKILLS: Operate equipment safely and correctly according to procedure. Execute arc welding procedures and techniques resulting in strong joints. Spray painting.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-3.1.1.6 Oxy-acetylene set welding equipment, tools, material and protective gear. Material characteristics, flux, filler material. Joint preparation, welding methods and techniques. Gas welding plants, procedures, precautions and flame types appropriate for different processes. MS1-**3.1.1.6** Gas Cutting

MS1 - 4.4 PROJECT: COMBINATION OF BRAZING AND ARC WELDING

Unit Standard Outcomes:
Learners can plan projects, compile a construction plan, make sketches and execution procedure according to OHS.
Learners can do all the measurements and calculations involved accurately.
Learners can make the different parts of the project, utilising cutting, drilling and shaping and demonstrate the ability to apply integrated knowledge.
Learners can weld the different parts together meticulously and join the components into a usable piece of equipment.
Learners can motivate their choices and calculations verbally and in writing using grammatically correct language and spelling; show calculations.

Curriculum Outcomes:
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.

Critical Outcomes:
Communicate effectively using visual, symbolic and/or language skills in various modes.
Organise and manage themselves and their activities responsibly and effectively.
Identify and solve problems and make decisions using critical and creative thinking.
Explore education and career opportunities.

Knowledge Foundation: OHS. Language: speak, read and write. Science,Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metalwork.

Learner Activities: Active participation: execute the manual labour, calculations. Reflect verbally, write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

4.4.1 PROJECT PLANNING	4.4.3 PROJECT, SITE LAYOUT	4.4.5 WELDING, BRAZING THE JOINTS	4.4.6 FINISHING AND PROTECTION
4.4.1.1 Planning and Welding Schedule	4.4.3.1 Method of Cutting, Shaping, Trimming	4.4.5.1 Welding, Brazing Rod Selection	4.4.6.1 Trimming Welding, Sharp Edges, Splinters
4.4.1.2 Project Structure Plan and Sketch	4.4.3.2 OHS, Oxy-Acetylene Plant Preparation	4.4.5.2 Operating Oxy-Acetylene Plant	4.4.6.2 Check Operation, Functionality
4.4.1.3 Dimensions, Operational Calculations	4.4.3.3 Equipment, Tools Required, Work Space	4.4.5.3 Adjust Gas Pressure Regulators	4.4.6.3 Refining, Polishing, Paint Preparation
4.4.1.4 Material, Accessories Calculations	4.4.3.4 Welding, Brazing Rods, Flux, Method	4.4.5.4 Brazing Procedure; Arc Welding	4.4.6.4 Corrosion Protection - Paint, OHS
4.4.2 SELECTION OF MATERIAL	4.4.4 MAKE PROJECT PARTS	4.4.5.5 Comply with OHS	
4.4.2.1 Metal Selection, Durability, Corrosion	4.4.4.1 Cutting	4.4.5.6 Brazing on Top of Arc and vice versa	
4.4.2.2 Compatibility with Arc Welding, Brazing	4.4.4.2 Drilling	4.4.5.7 Cooling of Brazed Joints - Coefficients of Expansion	
4.4.2.3 Purpose, Use	4.4.4.3 Shaping (Bending, Twisting, Grinding)		

KNOWLEDGE: OHS. Electricity, arc welding, brazing processes, selection of methods, application of techniques, metal cutting, shaping, finishing, welding, brazing and corrosion protection. Plan a project, select material and develop a construction plan.

SKILLS: Operate equipment safely and correctly according to procedure. Execute welding, brazing procedures and techniques resulting in strong joints. Spray painting.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-3.1.1.6 Oxy-acetylene set welding equipment, procedures, precautions and flame types appropriate for different processes. Tools, material and protective gear. Material characteristics, flux, filler material. Joint preparation, welding methods and techniques. Gas welding plants, MS1-3.1.1.6 Gas Cutting.

MS1 - 5 PROJECT PROCEDURES

February 2011

Unit Standard Outcomes:	Learners can plan projects, compile a construction plan, make sketches, drawings and execution procedure according to OHS. Learners can do all the calculations involved accurately. Learners can make the different parts of the project, utilising cutting, drilling and shaping and demonstrate the ability to apply integrated knowledge. Learners can weld the different parts together meticulously and join the components into a usable piece of equipment. Learners can motivate their project choices; explain operations, verbally and in writing using grammatically correct language and spelling; show calculations.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Organise and manage themselves and their activities responsibly and effectively. Identify and solve problems and make decisions using critical and creative thinking. Explore education and career opportunities.

Knowledge Foundation: OHS. Language: speak, read and write. Science,Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metalwork.

Learner Activities: Active participation, execute the manual labour, calculations. Reflect verbally, write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

5.1 PROJECT PLANNING	5.2 PROCUREMENT	5.3 PROJECT LAYOUT	5.4 ASSEMBLING
5.1.1 Planning Schedule	5.2.1 Material Quotations	5.3.1 Site Preparation	5.4.1 Joining the parts
Need, Demand, Purpose, Function/Operation	5.2.2 Overhead Costs	Work Area and Basic Equipment (Table, Vice)	Apply Construction Plan (Starting Point)
Rough Sketches, Discussions, Practicability	5.2.3 Material Cost Calculations	Equipment, Tools Access and Work Space	Select Most Appropriate Method for each Part
5.1.2 Structure Plan and Sketch, Construction Plan,	5.2.4 Time Schedule and Labour Costs	5.3.2 Selection of Material, Measurements	Do Welding According to Procedure and OHS
Operational Features, Practicalities	5.2.5 Production Costs	Consult Construction Plan, Procedure	Assemble Parts, Check Operation, Functionality
5.1.3 Sketches/Drawings	5.2.6 Profit, Price Calculation	5.3.3 Making Project Parts	5.4.2 Finishing
Dimensions, Proportions, Material, Strength	5.2.7 Material Purchasing	Cutting, Trimming, Prepare Welding Joints	Trimming Welding, Sharp Edges, Splinters
5.1.4 Dimensions, Operational Calculations	Analyse, Compare Material Quality and Prices	Drilling, Bending and Shaping (Angles etc.)	Shaping, Refining, Polishing
5.1.5 Material, Accessories Calculations	Compare Delivery/Transport Costs	5.3.4 Project Layout: Construction Plan	5.4.3 Corrosion Protection

KNOWLEDGE: OHS. Electricity, metal cutting, shaping, finishing, welding and corrosion protection. Plan and design a project, obtain material and develop a construction plan.

SKILLS: Operate equipment safely and correctly according to procedure. Execute welding procedures and techniques resulting in strong joints. Systematically construct the components and assemble them into a useful object. Spray painting.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1.3 Hand Power Tools, .1.4.2 Welders, 3.1.1.6 Oxy-Acetylene Set Welding equipment, tools, material and protective gear. Material characteristics, shielding gasses, flux, filler material. Joint preparation, welding methods and techniques. Gas welding plants, procedures, precautions and flame types appropriate for different processes.

MS1 - 6.1 MOTOR VEHICLE LAYOUT

February 2011

Unit Standard Outcomes:	Learners can locate and identify vehicle components, describe functions in relation to vehicle operation. Learners can explain construction of component mountings, functions and locking devices. Learners can demonstrate the operation of controls and write a report on their experiences in grammatically correct language.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS, MS1-1.2 Hand Tools, MS1-2.2 Vehicle Hoist, Language.

Learner Activities: Learners put a vehicle on a hoist, identify components. Take notes of information provided, reflect verbally and write a report on the information provided.

Presentation policy: Learning by doing - Learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

VEHICLE COMPONENTS

6.1.1 IDENTIFICATION	6.1.2 FUNCTIONS	6.1.3 MOUNTINGS	6.1.4 LOCKING DEVICES	6.1.5 CONTROL LINKS AND WIRING
6.1.1.1 Engine	6.1.2.1 Engine	6.1.3.1 Engine	6.1.4.1 Method, Purpose	6.1.5.1 Engine Speed Control
6.1.1.2 Gearbox	6.1.2.2 Gearbox	6.1.3.2 Gearbox	6.1.4.2 Method, Construction	6.1.5.2 Cold Starting
6.1.1.3 Final Drive	6.1.2.3 Final Drive	6.1.3.3 Final Drive	6.1.4.3 Detachment	6.1.5.3 Clutch
6.1.1.4 Driving Shaft(s)	6.1.2.4 Driving Shaft(s)	6.1.3.4 Suspension	6.1.4.4 Reusable/Compulsory Replacement	6.1.5.4 Gearbox
6.1.1.5 Suspension	6.1.2.5 Suspension	6.1.3.5 Shock Absorbers		
6.1.1.6 Shock Absorbers	6.1.2.6 Shock Absorbers	6.1.3.6 Battery	6.1.4.5 Tightening, Locking/ Securing	
6.1.1.7 Battery	6.1.2.7 Battery	6.1.3.7 Alternator		
6.1.1.8 Alternator	6.1.2.8 Alternator	6.1.3.8 Radiator		
6.1.1.9 Starter	6.1.1.9 Starter	6.1.3.9 Cooling Fan		
6.1.1.10 Radiator	6.1.2.10 Radiator			
6.1.1.11 Cooling Fan	6.1.2.11 Cooling Fan			

KNOWLEDGE: OHS. Vehicle component names, functions and control. Component mountings and securing devices. Vehicle care.

SKILLS: Safety procedures. Drive a vehicle onto a vehicle hoist. Operate the vehicle hoist, identify components and mountings. Vehicle care. Remove vehicle from the hoist and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS2-7.2 Engine operation. Mechanics: force and torque. Science: friction, lubricants, heat. Mathematics: arithmetic, trigonometry, LCM. Gears.

MS1 - 6.2 REPLACE SHOCK ABSORBERS

February 2011

Unit Standard Outcomes: Learners can locate and identify shock absorbers, mountings, locking devices, describe functions in relation to vehicle operation.
Learners can remove shock absorbers, using the right tools correctly and equipment according to procedure and OHS.
Learners can demonstrate and explain the operation of shock absorbers and write a report on their experiences using grammatically correct language and spelling.
Learners can do the basic calculations and explain the physics to demonstrate comprehension and appreciation of the functioning of shock absorbers.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-.1 OHS; Vehicle Care; MS1-1.2 Hand Tools; MS1-2.2 Vehicle Hoist. Language; basic mathematics; mechanics; basic physics - energy, forces.

Learner Activities: Learners put a vehicle on a hoist, identify components. Replace shock absorbers. Take notes of information provided, reflect verbally and write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.2.1 SITE PREPARATION	6.2.2 LIFT, SECURE VEHICLE	6.2.3 REMOVE SHOCK ABSORBERS	6.2.4 FIT NEW SHOCK ABSORBERS	6.2.5 LOWER VEHICLE, CLEAN UP
6.2.1.1 Select Equipment, Tools	6.2.2.1 Adjust Vehicle Hoist Track Width	6.2.3.1 Detach Locking Device (Opt)	6.2.4.1 Shock Construction, Operation	6.2.5.1 Clear Area
6.2.1.2 Determine Vehicle Mass and Compare with Hoist Capacity	6.2.2.2 Drive Vehicle onto Hoist	6.2.3.2 Unscrew Nut/Bolt and Nut	6.2.4.2 Mounting Procedure	6.2.5.2 Lowering Procedure
	6.2.2.3 Secure (Chock) Vehicle	6.2.3.3 Remove Shock Absorber	6.2.4.3 Adjust Shock (Optional)	6.2.5.3 Remove Chocks
6.2.1.3 Clean Area, Remove Obstacles	6.2.2.4 Lift Vehicle to Desired Height	6.2.3.4 Check for Damage	6.2.4.4 Mount shock, Secure	6.2.5.4 Drive Vehicle off Hoist
6.2.1.4 Set Work Table/Trolley	6.2.2.5 Secure Hoist/Lock/Chock	6.2.3.5 Test Operation	6.2.4.5 Check Operation	6.2.5.5 Clean Vehicle and Work Area

KNOWLEDGE: OHS. Shock absorber operation - controlled displacement of liquid, volumes below, above piston and reservoir. Conversion of kinetic energy into heat. Why shocks cannot work upside down. Reservoir pressure and increase of pressure from external source. Forces on shock absorber, angle of shock in relation to wheel movement and effects. Function of and effects of shocks too hard or too soft - relation to vehicle mass. Bump, speed, momentum, inertia and effects on driving comfort and vehicle control. Basic calculations to demonstrate and support theory. Work report and relevant documentation. Language, physics, mechanics, basic math. Calculation of displacement from the upper chamber to the lower chamber and vice versa.

SKILLS: Safety procedures. Drive a vehicle onto a vehicle hoist and secure. Operating the vehicle hoist. Remove shock absorbers, check and test. Mount new shock absorbers check operation. Vehicle care. Remove vehicle from the hoist and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-1.1; MS1-1.2; MS1-2.2. Mechanics: forces, triangle, parallelogram. Science: kinetic energy, heat; pressures in liquids and gasses. Pressure on surfaces/areas - converted into reaction forces. Mathematics: arithmetic, trigonometry, volumes.

Unit Standard Outcomes:	Learners can remove wheels according to manufacturer's procedure and complying to OHS. Learners can mount wheels and correct tyre pressures according to manufacturer's procedure and specifications complying to OHS. Learners can explain the Regulations regarding tyres and tread. Learners can explain the relationships between tyre friction on road surface, heat and gas pressure to demonstrate comprehension and appreciation of vehicle handling, control, tyre wear.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS, Vehicle Care, MS1-1.2 Hand Tools, MS1-2.2 Vehicle Hoist. Language, basic mathematics, basic physics - temperature-volume relationship.

Learner Activities: Learners put a vehicle on a hoist, identify components. Take notes of information provided, reflect verbally and write a report on the information provided.

Presentation policy: Learning by doing - Learners acquire knowledge, skills and values while demonstrating procedures and discussing tyre grip and vehicle control.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.3.1 SITE PREPARATION	6.3.2 LIFT, SECURE VEHICLE	6.3.3 REMOVE THE WHEELS	6.3.4 MOUNT WHEELS	6.3.5 LOWER VEHICLE, CLEAN UP
6.3.1.1 Select Equipment, Tools	6.3.2.1 Adjust Vehicle Hoist Track Width	6.3.3.1 Remove Wheel Trimmings	6.3.4.1 Tyre Features and Characteristics	6.3.5.1 Clear Area
6.3.1.2 Determine Vehicle Mass and Compare with Hoist Capacity	6.3.2.2 Drive Vehicle onto Hoist	6.3.3.2 Unscrew Nuts/Bolts	6.3.4.2 Have New Tyres Fitted (Experts)	6.3.5.2 Lowering Procedure
	6.3.2.3 Secure (Chock) Vehicle	6.3.3.3 Remove Wheels	6.3.4.3 Manufacturer Specs, Procedure	6.3.5.3 Remove Chocks
6.3.1.3 Clean Area, Remove Obstacles	6.3.2.4 Lift Vehicle to Desired Height	6.3.3.4 Check for Damage, Wear	6.3.4.4 Mount Wheels (Torque Specs)	6.3.5.4 Drive Vehicle off Hoist
6.3.1.4 Set Work Table/Trolley	6.3.2.5 Secure Hoist/Lock/Chock	6.3.3.5 Select New Tyres	6.3.4.5 Mount Wheel Trimmings	6.3.5.5 Clean Vehicle and Work Area

KNOWLEDGE: OHS. Road Ordinance on Wheels and Tyres. Torque adjustments on pneumatic and electrical wrenches. Wheel balance, effects on vehicle control, comfort, tyre and bearing wear. Conversion of kinetic energy into heat - friction, heat, gas pressure/temperature. Basic calculations to demonstrate and support theory. Work report and relevant documentation. Language, physics, mechanics, basic mathematics.

SKILLS: Safety procedures. Drive a vehicle onto a vehicle hoist and secure. Operate the vehicle hoist. Remove wheels, check tread, damage. Mount new balanced wheels, check rotation. Vehicle care. Remove vehicle from the hoist and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mechanics: Vectors, Force, Torque, Couples. Science: friction, kinetic energy, heat; pressures in gasses; volume, temperature and pressure. Mathematics: arithmetic, trigonometry, equations, functions.

MS1 - 6.4 REPLACE DISC PADS

February 2011

Unit Standard Outcomes: Learners can remove disc-brake pads according to manufacturer's procedure and complying to OHS.
Learners can mount wheels and correct tyre pressures according to manufacturer's procedure and specifications complying to OHS.
Learners can explain friction and stopping a vehicle, conversion of kinetic energy into heat and demonstrate comprehension of the engine converting heat energy into kinetic energy to propel the vehicle while the brakes convert kinetic energy into heat to stop the vehicle.
Learners can write an inspection report, reflect on their experiences verbally and in writing.

Curriculum Outcomes: Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Demonstrate practical application of integrated declarative and procedural knowledge in task execution.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS; Vehicle Care MS1-1.2 Hand Tools; MS1-2.2 Vehicle Hoist. Language, basic mathematics, basic physics - temperature, friction-heat relationship.

Learner Activities: Learners put a vehicle on a hoist, identify components. Make sketches of vehicle and trolley jack movements when lifting only one end of a vehicle. Replace disc pads according to the procedure. Take notes of information provided, reflect verbally and write a report on the experiences and information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating procedures and discussing tyre grip and vehicle control.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.4.1 PREPARATION	6.4.3 REMOVE THE WHEELS	6.4.5 REPLACE BRAKE PADS	6.4.6 MOUNT WHEELS	6.4.7 LOWER VEHICLE, CLEAN UP
6.4.1.1 Select Equipment, Tools	6.4.3.1 Remove Wheel Trimmings	6.4.5.1 Remove Locks, Retaining Pins	6.4.6.1 Mount Wheels - Procedure	6.4.7.1 Clear Area
6.4.1.2 Avoid Brake Fluid Spillage*	6.4.3.2 Remove Wheels	6.4.5.2 Push pistons back to make room for new pads*	6.4.6.2 Mount Wheel Trimmings	6.4.7.2 Lowering Procedure
6.4.2 LIFT, SECURE VEHICLE	6.4.4 CHECK BRAKE SYSTEM			6.4.7.3 Remove Trestles, Clear Space
6.4.2.1 Jack Up the Vehicle	6.4.4.1 Examine the Disc Pads	6.4.5.3 Slide new Pads in Position		6.4.7.4 Lower and Remove Jack
6.4.2.2 Secure it on trestles	6.4.4.2 Examine Discs and Run Out	6.4.5.4 Put Pins and Locks Back		6.4.7.5 Clean Vehicle and Work Area
*Reservoir overflow when making room for thicker new pads	6.4.4.3 Check for Fluid Leaks	6.4.5.5 Depress Pedal to take up Play		
	6.4.4.4 Check for Damage, Wear	6.4.5.6 Check Reservoir Fluid Level		

KNOWLEDGE: OHS. For lifting only one end of vehicle, allow for jack and vehicle wheels to roll. The basic factors determining brake efficiency: mean effective diameter, fluid pressure and coefficient of friction. Basic calculations to demonstrate and support theory. Work report and relevant documentation. Language, physics, mechanics, basic maths.

SKILLS: Safety procedures. Lifting and securing a vehicle. Remove wheels, check for damage and wear on brake components. Replace brake pads without spilling brake fluid. Vehicle care. Remove vehicle from the trestles and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions. Execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Science: friction, kinetic energy, heat. Brake convert kinetic energy into heat energy. Mathematics: brake torque in relation to disc diameter. Language: spelling, sentence structure, expressions.

MS1 - 6.5 REPLACE EXHAUST SYSTEM

February 2011

Unit Standard Outcomes:	Learners can plan exhaust system replacement procedure and replace the exhaust system safely and meticulously according to OHS and manufacturer procedures. Learners can explain the operation of an exhaust system with silencer and write a report on their experiences using grammatically correct language and spelling. Learners can explain the composition of harmful chemicals in engine exhaust gasses and demonstrate comprehension of the harmful effects of noise and air pollution.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS; Vehicle Care; MS1-1.2 Hand Tools; MS1-2.2 Vehicle Hoist. Language; basic mathematics; mechanics; basic physics - energy, forces.

Learner Activities: Learners put a vehicle on a hoist, identify components. Take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.5.1 PREPARATION	6.5.2 REMOVE EXHAUST SYSTEM	6.5.3 FIT NEW EXHAUST SYSTEM	6.5.4 WRAPPING UP OPERATIONS
6.5.1.1 Select Equipment, Tools	6.5.2.1 Detach Section Joints	6.5.3.1 Fitment Procedure and Sequence	6.5.4.1 Silencer Function and Operation
6.5.1.2 Hoist Procedure	6.5.2.2 Remove Sections - Procedure (Heating	6.5.3.2 Fit Section by Section and Secure Joints	6.5.4.2 Effect on Engine Performance
6.5.1.3 Inspection, Fuel Line, Wiring Routeing	6.5.2.3 Unscrew Manifold Mounting Bolts/Nuts	6.5.3.3 Attach Mountings (Rubbers)	6.5.4.3 Effect of Tailpipe Length and position
6.5.1.4 Procedure Plan, Sections for Removal	6.5.2.4 Remove Front Piece	6.5.3.4 Ensure Free Movement of Exhaust System	6.5.4.4 Vehicle Delivery Preparation
6.5.1.5 Mounting Detachment Procedure	6.5.2.5 Clean Packing Area on Manifold	6.5.3.5 Check for Gas Tightness - Leak Free	6.5.4.5 Tidy-Up Operation

KNOWLEDGE: OHS. Combustion noise, noise pollution, air pollution and Road Ordinance. Temperature of exhaust gasses. Chemical composition of engine exhaust gasses, indentify harmful substances and their health risks and environmental effects. Work report and complete relevant documentation. Language, basic chemistry.

SKILLS: Safety procedures. Drive a vehicle onto a vehicle hoist and secure. Operate the vehicle hoist. Remove exhaust system. Mount new system and check operation. Vehicle care. Remove vehicle from the hoist and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions. Execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS2-7.2. Basics of Combustion Process and Resulting Products. Basic Chemistry of Combustion. Air Pollution and Effects on the Environment. Sound and Noise Pollution and Detrimental Effects on the Environment.

MS1 - 6.6 REPLACE RADIATOR

February 2011

Unit Standard Outcomes: Learners can plan radiator replacement procedure, replace it safely and meticulously according to OHS and manufacturer specifications and procedures.
Learners can explain the composition of coolant and give the reasons for coolant additives.
Learners can explain the function and operation of a cooling system and write a report on their experiences using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the required skills by calculated execution of assignments through correctly performing procedure, techniques and specifications.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS, MS1-1.2 Hand Tools, Vehicle Care. Language, basic mathematics, mechanics, basic physics - energy, forces.

Learner Activities: Learners put a vehicle on a hoist, identify components. Take notes of information provided, reflect verbally and write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.6.1 VEHICLE PREPARATION	6.6.2 REMOVE RADIATOR	6.6.3 MOUNT RADIATOR, NEW/REPAIRED	6.6.4 WRAPPING UP OPERATIONS
6.5.1.1 Select Equipment, Tools	6.6.2.1 Detach Electric Wiring, Connections	6.6.3.1 Fitment Procedure and Sequence Plan	6.6.4.1 Refill the Cooling System to Level, Close
6.5.1.2 Drain Coolant,	6.6.2.2 Remove Fan, Fan Cowling/Electric Fan	6.6.3.2 Mount Radiator, Secure	6.6.4.2 Run Engine up to Operating Temperature
6.5.1.3 Examine Coolant, Write Report	6.6.2.3 Remove Radiator, Expansion Tank Hoses	6.6.3.3 Mount Fan, Fan Cowling/Electric Fan	6.6.4.3 Check System for Leaks, Defects
6.5.1.4 Procedure Plan, Sequence of Demounting	6.6.2.4 Unscrew Radiator Mounting Bolts/Nuts	6.6.3.4 Install Radiator Hoses, Secure Clamps	6.6.4.4 Prepare Vehicle for Delivery
6.5.1.5 Examine Fan Belt and Fan/Electric Fan	6.6.2.5 Remove Radiator from Vehicle	6.6.3.5 Replace Fan Belt and Adjust Tension	6.6.4.5 Clean Up Work Area, Equipment, Tools
	6.6.2.6 Clean and Examine Radiator, Mountings	6.6.3.6 Mix Coolant according to Specification	

KNOWLEDGE: OHS. Function and operation of the cooling system. Cooling system components. Composition of coolant and contribution of additives. Construction and operation of a radiator. Heat conduction of different materials/metals. Convection currents in liquids and reasons for direction of coolant flow. Work report and relevant documentation. Language, basic chemistry, calculation of resultant heat capacity of mixture.

SKILLS: Safety procedures. Drain coolant, remove relevant components and radiator. Vehicle care. Prepare vehicle for delivery and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-7.2: Results of Combustion: Heat, Expansion. Heat Release in Combustion process. Temperature-heat relationship. Operating temperature of vehicles, pressurised cooling systems, pressure and boiling point. Heat capacities of water and additives. Effect of coolant composition on heat capacity. Heat transfer: radiation, conduction and convection.

Unit Standard Outcomes: Learners can locate and identify battery, terminals, polarity, volts, current, battery rack, hold-down. and describe the function and features of each.
Learners can remove and replace the battery according to prescribed procedure.
Learners can charge a battery safely; know when a battery is fully charged, and how to connect batteries to obtain specific voltage and capacity.
Learners demonstrate appreciation of property, tidiness, and interpersonal relationships.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Demonstrate capacity to operate in workplace environments and sensitivity towards environmental issues, e.g. disposal of batteries and chemicals.
Demonstrate the ability to diagnose systematically, identify defects and propose feasible solutions.

Critical Outcomes: Communication. Science, Technology. Information
Communicate effectively using visual, symbolic and/or language skills in various modes.
Use science and technology effectively and critically, showing responsibility towards the environment and the health of others.
Organise and manage themselves and their activities responsibly and effectively.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: 1.1 OHS, 1.2 Hand Tools, 5.1 Vehicle Layout.

Learner Activities: Remove battery from vehicle, clean battery box, replace battery. Take notes of information provided, reflect verbally, write a report on the information and proceedings. Do basic calculations.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while executing a lubrication service and discussing procedures.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.7.1 ACIDS, CHEMICALS PROCEDURE	6.7.2 SELECT TOOLS, EQUIPMENT	6.7.4 CLEANING	6.7.7 BATTERY FEATURES	6.7.8 CHARGING PROCEDURE
6.7.1.1 Personal Protection	6.7.2.1 Tools	6.7.4.1 Chemicals and Application	6.7.7.1 Voltage, Current, Power, Capacity	6.7.8.1 Precautions, Connections
6.7.1.2 Vehicle Protection, Care	6.7.2.2 Safety Gear	6.7.4.2 Rinsing and Drying	6.7.7.2 Battery Pairs and Packs	6.7.8.2 Charging Rate, Duration
6.7.1.3 Battery Features	6.7.3 Remove Battery, Procedure	6.7.5 External Inspection	6.7.7.3 Selecting a New Battery	6.7.8.3 Battery Fully Charged?
6.7.1.4 Electrical System Features	6.7.3.1 Neutralise Acid/Chemicals	6.7.5.1 Box, poles, Cover, Filler Caps	6.7.7.4 Volt, Capacity Calculations	6.7.8.4 Precautions, Disconnection
6.7.1.5 Conductors and Isolators	6.7.3.2 Precautions, Disconnecting	6.7.6 Internal Inspection	6.7.7.5 Battery Life, Max Full Cycles	6.7.8.5 Prepare Battery, Installation
6.7.1.6 Short Circuits, Resistance, Loose Connections	6.7.3.3 Handling the Battery	6.7.6.1 Electrolyte	6.7.7.6 Mount Battery	6.7.9 Cleaning Up
	6.7.3.4 Dangers of Reversed Polarity	6.7.6.2 Plates and Separators	6.7.7.7 Connect Battery	6.7.9.1 Neutralise Acid, Tidy Up

KNOWLEDGE: OHS. Tools, purposes, use. Battery features, dangers, handling, removal, replacement, basics of electricity, conductors, isolators, resistance. Volts, amps, ohm and watt. Basic calculations. Determine current seepage from battery. Language: grammar, spelling, expressions.

SKILLS: Safety procedures, vehicle care, handling of tools and equipment. Service procedures, inspection procedures. Replace a battery.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Chemical reactions during charging and discharging, the gasses released during these processes and their explosive potential. Battery tests: discharge, voltage, hydrometer, internal resistance. Assess the condition of a battery.

MS1 - 6.8 REPLACE ALTERNATOR

February 2011

Unit Standard Outcomes: Learners can plan alternator replacement procedure, replace it safely and meticulously according to OHS and manufacturer specifications and procedures.
Learners can adjust drive belt tension correctly and explain the significance of belt tension.
Learners can explain the basics of alternator function, construction and operation and write a report on their experiences in grammatically correct language and spelling and make simple electrical calculations.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the required skills by calculated execution of assignments through correctly performing procedure, techniques and specifications.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS; Vehicle Care; MS1-1.2 Hand Tools; Language, basic mathematics.

Learner Activities: Active participation: replace alternator. Take notes of information provided, reflect verbally and write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing the charging system and features.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.8.1 PROCEDURE PLAN	6.8.2 DISMANTLING	6.8.3 INSPECTION	6.8.4 MOUNTING	6.8.5 WRAPPING UP
6.8.1.1 Work Area, Tools, Equipment	6.8.2.1 Detach Battery Earth	6.8.3.1 Examine Wiring	6.8.4.1 Mount Alternator on Bracket	6.8.5.1 Remove Loose Objects
6.8.1.2 Procedure - Consult Service Manual	6.8.2.2 Detach Electric Wiring	6.8.3.2 Examine Mounting Bracket	6.8.4.2 Attach Belt Tensioner	6.8.5.2 Test Voltage Output
	6.8.2.3 Loosen Belt Tensioner	6.8.3.3 Examine Tensioner	6.8.4.3 Install Drive Belt	6.8.5.3 Recheck Belt Tension
6.8.1.3 Safety, Precautions	6.8.2.4 Slack Off Pivot Bolt(s)	6.8.3.4 Examine Bolts and Nuts	6.8.4.4 Tighten Belt (Specification)	6.8.5.4 Prepare Vehicle for Delivery
6.8.1.4 Test Voltage Output	6.8.2.5 Remove Drive Belt (Fan Belt)	6.8.3.5 Examine Drive Belt	6.8.4.5 Tighten Mounting Bolts (Specs)	6.8.5.5 Put Tools, Equipment Away
6.8.1.5 Vehicle Paint Protection	6.8.2.6 Unscrew Bolts, Remove Alternator	6.8.3.6 Clean Bracket and Area	6.8.4.6 Attach Wiring	6.8.5.6 Tidy Up Work Area
			6.8.4.7 Attach Battery Earth Terminal	

KNOWLEDGE: OHS. Function and operation of the charging system. Charging system components. Basic Physics: electricity, PD, EMF, current, resistance. Conversion of AC to DC. Charging voltage of alternators and battery charging. Power. Calculate vehicle charging capacity required. Belt tension and driving efficiency. Belt tension and pulley, belt and bearing wear. Work report and completion of relevant documentation. Language, basic calculations.

SKILLS: Safety procedures. Prevent short circuiting, remove and mount alternator according to procedure.

VALUES: Communication etiquette, respect. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-6.7 Battery replacement. Electric wiring. Power, volts, amps, ohm calculations. Wiring diagrams. Volts, amps, ohms in terms of atom theory. Current rectifiers and inverters. Manipulation of formula.

MS1 - 7.1 REPLACE STARTER

Unit Standard Outcomes: Learners can plan starter replacement procedure, replace it safely and meticulously according to OHS and manufacturer specifications and procedures.
Learners can measure voltage drop, explain its significance and heat and gas generation in the battery.
Learners can explain why heat is generated, the effect on starter life and negative effect of overheating.
Learners can explain the basics of starter function, construction and operation and write a report on their experiences using grammatically correct language and spelling and make simple electrical calculations.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate the required skills by calculated execution of assignments through correctly performing procedure, techniques and specifications.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Use science and technology effectively and critically, showing responsibility towards the environment and the health of others.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: 1.1 OHS, Vehicle Care, 1.2 Hand Tools. Language, basic mathematics, basic electricity.

Learner Activities: Active participation, remove, mount starter. Take notes of information provided. Reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - Learners acquire knowledge, skills and values while demonstrating and discussing the starting system and features.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

7.1.1 PROCEDURE PLAN	7.1.2 DISMANTLING	7.1.3 INSPECTION	7.1.4 MOUNTING STARTER	7.1.5 WRAPPING UP
7.1.1.1 Work Area, Tools, Equipment	7.1.2.1 Detach Battery Earth	7.1.3.1 Examine Wiring and Cable	7.1.4.1 Slide Starter into Bell Housing	7.1.5.1 Remove Loose Objects
7.1.1.2 Procedure - Consult Service Manual	7.1.2.2 Detach Electric Wiring	7.1.3.2 Examine Mounting Face	7.1.4.2 Screw Up Bolts/Nuts (Torque)	7.1.5.2 Test Starter Operation
	7.1.2.3 Unscrew Bolts/Nuts	7.1.3.3 Examine Bolts and Nuts	7.1.4.3 Install Drive Belt	7.1.5.3 Check Voltage Drop
7.1.1.3 Safety, Precautions	7.1.2.4 Slide Starter out of Bell Housing	7.1.3.4 Examine Ring Gear	7.1.4.4 Attach Cable	7.1.5.4 Prepare Vehicle for Delivery
7.1.1.4 Lifting, Securing Procedure			7.1.4.5 Attach Wiring	7.1.5.5 Put Tools, Equipment Away
7.1.1.5 Vehicle Paint Protection	7.1.2.5 Clean Mounting Area		7.1.4.6 Attach Battery Earth Terminal	7.1.5.6 Tidy Up Work Area

KNOWLEDGE: OHS. Function and operation of the starter. Starting system components. Basic physics: electricity, PD, EMF, current, resistance, power, heat generated. Battery capacity and duration/sustainability of high current discharge. Heat and gas generation in battery. Composition of the gasses released and the dangers involved. Work report and completion of relevant documentation. Language, basic calculations.

SKILLS: Safety procedures. Prevent short circuiting, remove and mount starter according to procedure. Measure voltage drop.

VALUES: Communication etiquette, respect. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1.1; 1.2; 6.7 Battery Replacement. 6.8 Alternator Replacement. Electric Wiring. Power, volts, amps, ohm calculations. Starter wiring diagrams. Volts, amps, ohms in terms of atom theory. Chemical reactions causing heat and gas release. Composition of the gasses released and the dangers involved. Heat and gas release during charging.

MS1 - 7.2 ENGINE REMOVAL

February 2011

Unit Standard Outcomes: Learners can identify components; know their functions and basic properties.
Learners can select the correct tools and equipment and follow the correct procedure to remove the components from the engine and the engine from the vehicle.
Learners can read safety rules, the procedures from study guides and/or manuals and reflect on these. "Read" sketches.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.
Learners can do mathematical, mechanics calculations related to the operations executed.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Communication. Science, Technology. Information
Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety, MS1-1.2 Tools, MS1-2.3 Engine Hoist, MS1-6.1 Vehicle Layout. MS1-6.5, MS1-6.6, MS1-6.7, MS1-6.8, MS1-7.1. Arithmetic, equations, trigonometry, language.

Learner Activities: Active participation, detach and remove engine. Calculate resultant forces in sling, leverage of engine hoist, pressure in cylinder to produce resultant force to lift engine. Take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

7.2.1 PREPARATION PLAN	7.2.2 REMOVE SUPPORT COMPONENTS	7.2.3 UNMOUNT, REMOVE ENGINE	7.2.4 WRAPPING UP OPERATIONS
7.2.1.1 Procedure Plan	7.2.2.1 Detach Battery Earth, Positive	7.2.3.1 Detach, Secure Gearbox	7.2.4.1 Clean, Put Away Tools and Equipment
7.2.1.2 Site Preparation	7.2.2.2 Remove Battery	7.2.3.2 Detach Exhaust Pipe	7.2.4.2 Put Away, Secure Vehicle Components
7.2.1.3 Select Equipment and Tools	7.2.2.3 Detach Wiring	7.2.3.3 Detach Engine Mountings	7.2.4.3 Clean Worksite
7.2.1.4 Vehicle Preparation	7.2.2.4 Detach Control Linkages	7.2.3.4 Attach Sling to Engine: Avoid Small Angles*	7.2.4.4 Clean, Prepare Vehicle for Mounting Engine
7.2.1.5 Drain Lubricant and Coolant	7.2.2.5 Remove Alternator	7.2.3.5 Pull Engine out of Gearbox in Straight Line	7.2.4.5 Report Damages and Defects in Writing
7.2.1.6 Clean Engine	7.2.2.6 Remove Starter	7.2.3.6 Pull Engine Carefully out of Vehicle	
7.2.1.7 Calculate Forces in Sling	7.2.2.7 Detach Fuel Supply System	7.2.3.7 Attach Engine to Engine Stand	
7.2.1.8 Determine Sling Strength	7.2.2.8 Remove Radiator	7.2.3.8 Prepare Site for Engine Dismantling	
7.2.1.9 Mind Hoist Capacity	7.2.2.9 Remove Heater, Vacuum Hoses	7.2.3.9 Lay Out Tools and Equipment	

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Engine components, functions, care. Weight, force, mass. Leverage of engine hoist. Force to support and overcome engine mass (load). Pressure and resulting force on hydraulic piston. Safety, procedures and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures.

VALUES: Communication etiquette, respect for and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mechanics: forces and torque. Hydraulics: Pressure and resulting forces on pistons. Pump plunger-piston diameter ration, Force-load ration. Mathematics: arithmetic, trigonometry.

MS1 - 7.3 GEARBOX REMOVAL Front Engine - Rear Wheel Drive

February 2011

Unit Standard Outcomes: Learners can read safety rules, the gearbox removal procedures from study guides and/or manuals and reflect on it.
Learners can select the correct tools and equipment and follow the correct procedure to remove the gearbox from the vehicle.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.
Learners can do calculations: Math/Mechanics: ratios, force, and torque.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Communication. Science, Technology. Information
Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety; MS1-1.2 Tools; MS1-2.2 Vehicle Hoist; MS1-2.4 Gearbox Jack. MS1-6.1 Vehicle Layout. MS1-7.1 Remove Starter. Language.

Learner Activities: Active participation, detach and remove gearbox. Take notes of information provided, reflect verbally, write a report on the information and proceedings

Presentation policy: Learning by doing - Learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

7.3.1 PREPARATION PLAN	7.3.2 REMOVE CONTROLS and MONITORS	7.3.3 DEMOUNT, REMOVE GEARBOX	7.3.4 WRAPPING UP OPERATIONS
7.3.1.1 Procedure Plan (Manual/study Guide)	7.3.2.1 Detach Driving Shaft	7.3.3.1 Detach, Remove Driving Shaft	7.3.4.1 Mount Gearbox on a Gearbox Stand
7.3.1.2 Site Preparation	7.3.2.2 Detach Gear Lever	7.3.3.2 Unscrew Bolts except One at Top	7.3.4.2 Clean Gearbox
7.3.1.3 Select Equipment and Tools	7.3.2.3 Detach Wiring	7.3.3.3 Secure Gearbox on Gearbox Jack	7.3.4.3 Clean, Put Away Tools and Equipment
7.3.1.4 Lift Vehicle with Hoist, Secure	7.3.2.4 Detach Speedometer Drive	7.3.3.4 Remove Remaining Bolt	7.3.4.4 Put Away, Secure Vehicle Components
7.3.1.5 Drain Lubricant	7.3.2.5 Detach Clutch Cable/Pipe	7.3.3.5 Slide Gearbox in a Straight Line out of Clutch to Prevent Damage	7.3.4.5 Clean Worksite
7.3.1.6 Clean Gearbox, Body Area	7.3.2.6 Remove Starter (Some Vehicles)		7.3.4.6 Prepare Vehicle for Mounting Gearbox
7.3.1.7 Load vs Jack Capacity		7.3.3.6 Lower Gearbox Jack	7.3.4.7 Report Damages and Defects in Writing

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Gearbox, functions, care. Sacrifice speed, gain torque. Acceleration force. Calculate driving force from torque on drive wheels. Force to support and overcome engine mass (load). Pressure and resulting force on hydraulic piston. Safety, procedures, and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures. Remove gearbox from vehicle.

VALUES: Communication etiquette, respect for and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1.1; 1.2; 2.2; 2.4. Engine operation 7.3. Mechanics: forces, moments, torque power. Acceleration. Calculation of vehicle speed in different gears. Hydraulics: Pressure and resulting forces on pistons. Pump plunger-piston diameter ration, force-load ration. Mathematics: arithmetic, trigonometry.

MS1 - 7.4 FINAL DRIVE REMOVAL Front Engine - Rear Wheel Drive

February 2011

Unit Standard Outcomes:
Learners can read safety rules and gearbox removal procedures from study guides and/or manuals and reflect on these.
Learners can "read" the sketches from the manual; explain the construction of the rear axle assembly and the sequence of removing components needed for unmounting of the centrepiece.
Learners can select the correct tools and equipment and follow the correct procedure to remove the final drive from the vehicle.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.
Learners can do calculations: Math/Mechanics: ratios, force, and torque.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Communication. Science, Technology. Information
Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: 1.1 Safety, 1.2 Tools, 2.2 Vehicle Hoist, 2.4 Gearbox Jack. 6.1 Vehicle Layout. 7.3 Gearbox Removal. Language.

Learner Activities: Active participation: Remove final drive. Take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

7.4.1 PREPARATION PLAN	7.4.2 REMOVE REAR WHEELS, PARTS	7.4.3 REMOVE CENTREPIECE	7.4.4 WRAPPING UP OPERATIONS
7.4.1.1 Procedure Plan (Manual/Study Guide)	7.4.2.1 Detach Driving Shaft from Final Drive	7.4.3.1 Unscrew Bolts except One at Top	7.4.4.1 Mount Centrepiece on a Stand
7.4.1.2 Site Preparation	7.4.2.2 Remove Rear Wheels	7.4.3.2 Secure Centrepiece on Gearbox Jack	7.4.4.2 Clean Centrepiece
7.4.1.3 Select Equipment and Tools	7.4.2.3 Remove Brake Drums, Brake Shoe Assemblies	7.4.3.3 Remove Remaining Bolt	7.4.4.3 Clean, Put Away Tools and Equipment
7.4.1.4 Lift Vehicle with Hoist, Secure	7.4.2.4 Detach Side Shaft Mountings Brackets	7.4.3.4 Slide Centrepiece out of Housing	7.4.4.4 Put Away, Secure Vehicle Components
7.4.1.5 Lift Rear End for Wheels Removal	7.4.2.5 Slide Side Shafts Out of Centrepiece	7.4.3.5 Lower Gearbox Jack	7.4.4.5 Clean Worksite
7.4.1.6 Drain Lubricant			7.4.4.6 Prepare Vehicle for Mounting Centrepiece
7.4.1.7 Clean Final Drive	7.4.1.8 Load vs Jack Capacity		7.4.4.7 Report Damages and Defects in Writing

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Final drive functions, care. Sacrifice speed, gain torque. Final drive ratios and calculations. Different paths followed by vehicle wheels in a turn resulting in difference in rotational speed and differential operation. Equal torque on drive wheels despite different rotational speeds - same torque but more power on outer wheel. Gear types and reasons for design. Safety, procedures and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures. Dismantling rear brake assemblies, removing side shafts and centrepiece.

VALUES: Communication etiquette, respect for and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-1.1; MS1-1.2; MS1-2.2; MS1-2.4; MS1-7.3. Gear types, operation features, uses and advantages. Lubrication for different types of gears. Gear ratio calculations in different types of gear. Equal peripheral speeds but different rotational speeds. Pitch circle diameters, tooth profiles. Mechanics, manipulation of formula.

Unit Standard Outcomes:	Learners can describe the composition, features, dynamics, construction and maintenance of flat belt drives. Learners can calculate pitch circle (mean effective) diameters, ratios, power transmission. Learners can write a report on flat belt drives in grammatically correct language.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: 1.1 OHS. Power, torque, force. Arithmetic, manipulation of formula. Language.

Learner Activities: Learners take notes of information provided, reflect verbally, write a report and make sketches on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while participating in the presentation and discussions.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.1.1 COMPOSITION	8.1.2 FEATURES	8.1.3 DYNAMICS	8.1.4 CONSTRUCTION	8.1.5 MAINTENANCE
8.1.1.1 Pulleys	8.1.2.1 Versatility	8.1.2.1 Angle of Contact	8.1.4.1 Belt Structure	8.1.5.1 Slip Control, Belt Dressing
8.1.1.2 Straight Drive Arrangement	8.1.2.2 Alignment	8.1.2.2 Friction	8.1.4.2 Belt Materials	8.1.5.2 Belt, Joint Wear
8.1.1.3 Belt Profile	8.1.2.3 Conveyers	8.1.2.3 Belt Tensions	8.1.4.3 Pulley Materials	8.1.5.3 Secure Pulleys on Shafts
8.1.1.4 Joints	8.1.2.4 Advantages and Limitations	8.1.2.4 Power Transmission	8.1.4.4 Pulley fit on Shaft	8.1.5.4 Pulley Wear
8.1.1.5 Bearings, Bushes		8.1.2.5 Ratios	8.1.4.5 Keys and Locks	8.1.5.5 Bearings, Bushes

KNOWLEDGE: OHS. Arithmetic, manipulation of formula. Ratio and rotational speed calculations. Tensile strength, cross sectional area and mean, slack side, tight side forces. Driver and driven shafts/pulleys. Mean effective force, torque and power. Versatility of flat belt drives: driver and driven shaft positions, use of jockey (directional) pulleys. Maximum ratio without jockey pulley. Later developments: combined v-belts, grooved belts.

SKILLS: Safety procedures. Reading, writing, verbal communication. Utilising sketches, models, charts and relevant symbols to explain characteristics of flat belt drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1.1; 1.2. Mechanics: force and torque. Science: friction, heat. Mathematics: arithmetic, proportionality. Ratio and rotational speed calculations. Belt speed, centrifugal force and friction force - friction.

MS1 - 8.2 V-BELT DRIVES

February 2011

Unit Standard Outcomes: Learners can describe the composition, features, dynamics, construction and maintenance of v-belt drives.
Learners can calculate pitch circle (mean effective) diameters, ratios, power transmission.
Learners can write a report on v-belt drives in grammatically correct language.
Learners can do the basic calculations related to v-belt drives.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: 1.1 OHS. Power, torque, force. Arithmetic, manipulation of formula. Language.

Learner Activities: Learners take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while participating in the presentation and discussions. Write presentation report.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.2.1 COMPOSITION	8.2.2 FEATURES	8.2.3 DYNAMICS	8.2.4 CONSTRUCTION	8.2.5 MAINTENANCE
8.2.1.1 Pulleys	8.2.2.1 Versatility	8.2.2.1 Angle of Contact	8.2.4.1 Belt Structure	8.2.5.1 Slip Control
8.2.1.2 Straight Drive arrangement	8.2.2.2 Alignment	8.2.2.2 Friction	8.2.4.2 Belt Materials	8.2.5.2 Belt Wear
8.2.1.3 Belt Profile	8.2.2.3 V-Profile, Advantages, Friction	8.2.2.3 Belt Tensions	8.2.4.3 Pulley Materials	8.2.5.3 Secure Pulleys on Shafts
8.2.1.4 Bearings, Bushes	8.2.2.4 Advantages and Limitations	8.2.2.4 Power Transmission	8.2.4.4 Pulley fit on Shaft	8.2.5.4 Pulley Wear
		8.2.2.5 Ratios	8.2.4.5 Keys and Locks	8.2.5.5 Bearings, Bushes

KNOWLEDGE: OHS. Arithmetic, manipulation of formula. Ratio and rotational speed calculations. Tensile strength, cross sectional area and mean, slack side, tight side forces. The effect of the v-shape on force on the friction surfaces; simple triangle of forces, trigonometry calculations. Driver and driven shafts/pulleys. Mean effective force, torque and power. Driver and driven shaft positions, use of jockey (directional) pulleys. Maximum ratio without jockey pulley. Later developments: combined v-belts, grooved belts.

SKILLS: Safety procedures. Reading, writing, verbal communication. Utilising sketches, models, charts and relevant symbols to explain characteristics of v-belt drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1.1; 1.2. Mechanics: force and torque; calculate maximum force on friction surfaces; triangle of forces, vector diagrams. Science: friction, heat. Mathematics: arithmetic, proportionality, trigonometry for vector calculations. Ratio and rotational speed calculations. Belt speed, centrifugal force and friction force - friction.

Unit Standard Outcomes: Learners can describe the composition, features, dynamics, construction and maintenance of direct couplings.
Learners can mount direct couplings supported by educator for precision alignment.
Learners can calculate pitch circle (mean effective) diameters, pitch.
Learners can measure pitch circle (mean effective) diameters, pitch and compare these to the calculations.
Learners can write a report on direct couplings using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Organise and manage themselves and their activities responsibly and effectively.

Knowledge Foundation: 1.1 OHS. 4.1 Metal Knowledge. Power, torque, force. Arithmetic, manipulation of formula. Language.

Learner Activities: Learners examine direct couplings, discuss their construction, features, dynamics and maintenance. Do the calculations and find further sources of information about direct couplings. Mount direct couplings. Take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while examining, discussing and mounting direct couplings.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.3.1 SOLID COUPLINGS	8.3.2 FLEXIBLE COUPLINGS	8.3.3 ALIGNMENT	8.3.4 MAINTENANCE
8.3.1.1 Types of Solid Couplings	8.3.2.1 Types of Flexible Couplings	8.3.3.1 Precision Alignment - Solid Couplings Low Tolerances - Precision Instruments	8.3.4.1 Low Maintenance for Solid Couplings Torque Coupling Bolts and Nuts According to Schedule
8.3.1.2 Features of Solid Couplings	8.3.2.2 Features of Flexible Couplings		
8.3.1.3 Uses of Solid Couplings	8.3.2.3 Uses of Flexible Couplings	8.3.3.2 Flexible Coupling: Accuracy of alignment Differ. from Type to Type. Tolerances Vary According to Design	
8.3.1.4 Construction of Different Types	8.3.2.4 Construction of Different Types		8.3.4.2 Flexible Couplings: Maintenance Free to Low Maintenance
8.3.1.4 Mounting Flanges or Sleeves on Shafts	8.3.2.4 Mounting Flanges or Sleeves on Shafts		
8.3.1.5 Bearings, Bushes, Supports	8.3.2.5 Keys, Splines and Locks	8.3.3.3 Alignment Procedures - Solid, Flexible	

KNOWLEDGE: OHS. Arithmetic, manipulation of formula. Pitch circle diameter and bolt pitch calculations. Driver and driven shaft alignment procedures and measurements.

SKILLS: Safety procedures. Reading, writing summary of provided information and verbal communication in discussions. Utilising sketches, models, charts and relevant symbols to explain characteristics direct couplings. Information hunt to obtain more information on direct couplings.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.s

LINKS: 1.1; 1.2. Mechanics: force, torque and power. Mathematics: arithmetic, algebra. Flange and sleeve metal alloy properties. Crystal structure of metals.

MS1 - 8.4 ROLLER CHAIN DRIVES

February 2011

Unit Standard Outcomes:	Learners can describe the composition, features, dynamics, construction and maintenance of roller chain drives. Learners can calculate pitch circle (mean effective) diameters, ratios, power transmission. Learners can write a report on roller chain drives using grammatically correct language and spelling. Learners can do the basic calculations related to chain drives.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: 1.1 OHS. 4.1 Metal Knowledge. Power, torque, force. Arithmetic, manipulation of formula. 8.1 Flat belt drives, 8.2 V-belt drives. Language.

Learner Activities: Learners examine a roller chain drive, discuss its construction, features, dynamics and maintenance. Do the calculations and find further sources of information about chain drives. Take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - Learners acquire knowledge, skills and values while examining and discussing chain drives.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.4.1 COMPOSITION	8.4.2 CONSTRUCTION	8.4.3 FEATURES	8.4.4 DYNAMICS	8.4.5 MAINTENANCE
8.4.1.1 Gears (Sprockets)	8.4.2.1 Sprocket Construction	8.4.3.1 Number of Teeth in Contact	8.4.4.1 Positive Drive (No slip)	8.4.5.1 Lubrication
8.4.1.2 Roller Chain	8.4.2.2 Chain Construction	8.4.3.2 Roller Lubrication	8.4.4.2 Chain, Sprocket Contact	8.4.5.2 Wear Specifications/Replace
8.4.1.3 Straight Drive arrangement	8.4.2.3 Chain Materials	8.4.3.3 Chain Stretch, Teeth Contact	8.4.4.3 Chain Tensions	8.4.5.3 Gear Wear
8.4.1.4 Links	8.4.2.4 Sprocket fit on Shaft	8.4.3.4 Gear Teeth Strength	8.4.4.4 Power Transmission	8.4.5.4 Secure Pulleys on Shafts
8.4.1.5 Bearings, Bushes, Supports	8.4.2.5 Keys, Splines and Locks	8.4.3.5 Alignment	8.4.4.5 Ratios	8.4.5.5 Bearings, Bushes

KNOWLEDGE: OHS. Arithmetic, manipulation of formula. Ratio and rotational speed calculations. Tensile strength, slack side, tight side forces. Pitch circle diameter. Driver and driven sprockets. Driver and driven shaft positions, use of jockey pulleys/sprockets.

SKILLS: Safety procedures. Reading, writing summary of provided information and verbal communication in discussions. Utilising sketches, models, charts and relevant symbols to explain characteristics of chain drives. Information hunt to obtain more information on chain drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mechanics: force, torque and power. Mathematics: arithmetic, proportionality. Sprocket strength and durability, metal alloy properties. Crystal structure of metals.

MS1 - 8.5 SIMPLE GEAR DRIVES

Unit Standard Outcomes:	Learners can describe the composition, features, dynamics, construction and maintenance of gear drives. Learners can identify gear types, tooth types, and elaborate on their specific characteristics. Learners can calculate pitch circle diameters, ratios, torque and power transmission. Learners can write a report on gear drives using grammatically correct language and spelling.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: 1.1 OHS. 4.1 Metal Knowledge. Power, torque, force. Arithmetic, manipulation of formula. 8.1 Flat belt drives, 8.2 V-belt drives, 8.4 Chain drives. Language.

Learner Activities: Learners examine a gear drive, discuss its construction, features, dynamics and maintenance. Do the calculations and find further sources of information about gear drives. Take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while examining and discussing gear drives.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.4.1 COMPOSITION	8.4.2 CONSTRUCTION	8.4.3 FEATURES	8.4.4 DYNAMICS	8.4.5 MAINTENANCE
8.4.1.1 Gears: Driver and Driven	8.4.2.1 Gear Construction Tooth Type	8.4.3.1 Number of Teeth in Contact	8.4.4.1 Gear tooth contact Pattern	8.4.5.1 Lubrication
8.4.1.2 Gear Types	8.4.2.2 Gear Materials	8.4.3.2 Gear Lubrication - Type	8.4.4.2 Pitch and Pitch Circle Diameter	8.4.5.2 Wear Specifications/Replace
8.4.1.3 Bearings, Bushes, Supports	8.4.2.3 Gear fit on Shaft	8.4.3.3 Positive Drive (No slip)	8.4.4.3 Power Transmission	8.4.5.3 Gear Wear
8.4.1.4	8.4.2.4 Keys, Splines and Locks	8.4.3.3 Gear Teeth Strength	8.4.4.4 Ratios	8.4.5.4 Pit Marks, Causes
8.4.1.5	8.4.2.5	8.4.3.4 Alignment, Timing	8.4.4.5 Even Ratios, Tooth Contact	8.4.5.5 Bearings, Bushes
			8.4.4.6 Backlash, Lubrication	

KNOWLEDGE: OHS. Arithmetic, manipulation of formula. Driver and driven gears. Ratio and rotational speed calculations. Pitch circle diameter (PCD) and pitch. Comparison of pitch circle diameter and teeth ratios. Forces on teeth at PCD on both gears and torque on both gears. Lever effect.

SKILLS: Safety procedures. Reading, writing summary of provided information and verbal communication in discussions. Utilising sketches, models, charts and relevant symbols to explain characteristics of gear drives. Information hunt to obtain more information on gear drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1.1; 1.2. Mechanics: force, torque and power. Mathematics: arithmetic, proportionality. Gear strength and durability, metal alloy properties. Crystal structure of metals. Teeth strength and gear size. Lubrication and pitting of teeth. Lubrication qualities, SAE, API and manufacturer grading. Chemistry of oil.

MECHANICAL SKILLS 2

MS2 - 1 SPECIAL TOOLS

February 2011

Unit Standard Outcomes:	Learner can identify special tools, know their basic functions, properties and operations. Learners can select the correct tool for the specific job and handle it correctly and safely. Learners can motivate their choices verbally and in writing using grammatically correct language and spelling. Learners can do the basic calculations relevant to the tasks.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension . Demonstrate the required skills by calculated execution of assignments through correctly performing procedures and techniques.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: Language: speak, read and write. Mechanics: dimensions, leverage, torque, perpendicular force. Nuts, bolts, studs, stretch bolts.

Learner Activities: Active participation: list tools and state their functions and application. Torque bolts, studs and stretch bolts. Replace studs on an engine block. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

1 SPECIAL TOOLS AND CARE	1.1 TORQUE WRENCH	1.2 TORQUE PROTRACTOR	1.3 STUD REMOVER
Although only three of a variety of special tools are mentioned, these are guidelines applying to all special tools due to their value and indispensability.	1.1.1 Construction	1.2.1 Construction	1.3.1 Construction
	1.1.2 Operation	1.2.2 Function, Operation	1.3.2 Function, Operation
	1.1.3 Application	1.2.3 Application	1.3.3 Application
	1.1.4 Care	1.2.4 Care	1.3.4 Care

KNOWLEDGE: OHS. Tools, purposes, procedures. Basic Calculations. Protractor readings, torque wrench readings. Force and torque. Measure torque wrench length and calculate force from torque applied. Torque in terms of tension in bolts and studs. Bolt extension due to tension. General workshop practice.

SKILLS: Select tools and equipment for specific purpose, handle tools safely and correctly. Torque bolts, studs and stretch bolts. Replace studs on an engine block.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Language; Dimensions; Arithmetic; Leverage. Mass, force, moments, radial movement. Radial movement, screw thread pitch and resultant axial distance of stretch.

Unit Standard Outcomes:	Learner can identify precision measuring instruments; know their basic functions, properties and operations. Learners can select the correct instrument for the specific measurement, handle it correctly and safely and obtain a correct reading within tolerance. Learners can motivate their choices verbally and in writing using grammatically correct language and spelling. Learners can do the basic calculations relevant to the tasks.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: Language: speak, read and write. Mechanics: dimensions, and micro dimensions. Basic calculations.

Learner Activities: Active participation: List tools and state their functions and application. Take accurate measurements with all four instruments. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

2 PRECISION MEASURING INSTRUMENTS	2.1 VERNIER CALLIPER	2.2 DIAL GAUGE	2.3 MICROMETER, OUTSIDE	2.4 MICROMETER, INSIDE
Although only four of a variety of precision measuring instruments are mentioned these are guidelines applying to all instruments due to their value and indispensability.	2.1.1 Construction	2.2.1 Composition	2.3.1 Composition	2.4.1 Composition
	2.1.2 Function	2.2.2 Function	2.3.2 Function	2.4.2 Function
	2.1.3 Operation	2.2.3 Operation	2.3.3 Operation	2.4.3 Operation
	2.1.4 Measurements	2.2.4 Measurements	2.3.4 Measurements	2.4.4 Measurements
	2.1.5 Care	2.2.5 Care	2.3.5 Care	2.4.5 Care

KNOWLEDGE: OHS. Precision measuring instruments, purposes, procedures. Basic calculations. Measurements and their significance in mechanical skills. Tolerances.

SKILLS: Select instrument for specific task, handle it safely and correctly, take accurate measurements and record them.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Language; Dimensions; micro dimensions and applications. Clearances, Tolerances, Tight fit, Interference fit, Shrink fit.

MS2 - 3.1 SHAPING MACHINE

Unit Standard Outcomes:	Learner can select the cutter and tools for the specific job, know their basic functions, properties and operations. Learners can select the correct instrument for the specific measurement, handle it correctly and safely and obtain a correct reading within tolerance. Learners can motivate their choices verbally and in writing using grammatically correct language and spelling. Learners can do the basic calculations relevant to the tasks.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Use science and technology effectively and critically, showing responsibility towards the environment and the health of others. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: Language: speak, read and write. Mechanics: dimensions, and micro dimensions. Basic calculations. Vernier measurements.

Learner Activities: Active participation: operate shaping machine to execute a specific assignment. Take accurate measurements with Vernier. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

3.1.1 SHAPING MACHINE	3.1.2 VARIETY OF APPLICATIONS	3.1.3 METAL SURFACE SHAPING	3.1.4 KEYWAY CUTTING	3.1.5 CLEANING UP
3.1.1.1 Functions	3.1.2.1 Keyways - Internal, Blind Holes	3.1.3.1 OHS, Safety, Precautions	3.1.3.1 OHS, Safety, Precautions	3.1.5.1 Remove Work Piece
3.1.1.2 Construction	3.1.2.2 Dovetail slides	3.1.3.2 Operation and Adjustments	3.1.3.2 Operation and Adjustments	3.1.5.2 Remove Cutting Tools
3.1.1.3 Operation	3.1.2.3 Internal splines	3.1.3.3 Cutting Thickness	3.1.3.3 Cutting Size, Stroke	3.1.5.3 Remove Cutting Bits, Pieces
3.1.1.4 Tools and Cutters	3.1.2.4 Cam drums	3.1.3.4 Cutting Procedure	3.1.3.4 Cutting Procedure	3.1.5.4 Clean Machine and Tools
3.1.1.5 Valuable Supplement to Milling	3.1.2.5 Internal Features	3.1.3.5 Measurements	3.1.3.5 Measurements	3.1.5.5 Put Away Tools

KNOWLEDGE: OHS. Shaper function, construction and operation procedures. Determine size of cut - material removed in a single stroke. Effects of cut size. Basic Calculations. Measurements and their significance. Meticulous planning and execution of the task. The necessary measurements to be taken during operation. Tolerances.

SKILLS: Select cutter and tools for specific task, handle these safely and correctly, operate the shaper to execute the assignment, take accurate measurements and record them.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Language; Dimensions; micro dimensions and applications. Clearances. Tolerances. Fit. Calculations. Work that cannot be done with a milling machine. Strength of keys, design features.

Unit Standard Outcomes: Learner can select the cutter and tools for the specific job, know their basic functions, properties and operations.
Learners can select the correct instruments for the specific measurements, handle them correctly and safely and obtain a correct reading within tolerances.
Learners can motivate their choices verbally and in writing using grammatically correct language and spelling.
Learners can operate the lathe according to OHS, operating procedures and meticulously execute the assignment.
Learners can do the basic calculations relevant to the tasks.

Curriculum Outcomes: Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Use science and technology effectively and critically, showing responsibility towards the environment and the health of others.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: Language: speak, read and write. Mechanics: dimensions, and micro dimensions. Basic calculations. Vernier and micrometer measurements.

Learner Activities: Active participation: operate a lathe to execute a specific assignment. Use callipers and dividers. Take accurate measurements with Vernier and micrometer. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

3.2.1 LATHE	3.2.2 SIMPLE TURNING TASK	3.2.3 TURNING TO SPECIFIC SIZES	3.2.4 RUN-OUT MEASUREMENTS	3.2.5 CLEANING UP
3.2.1.1 OHS. Functions	3.2.2.1 Aligning Work Piece	3.2.3.1 OHS, Safety, Precautions	3.2.4.1 OHS, Safety, Precautions	3.2.5.1 Remove Work Piece
3.2.1.2 Construction	3.2.2.2 Select, Fit Cutting Tool	3.2.3.2 Operation and Adjustments	3.2.4.2 Alignment of Work Piece	3.2.5.2 Remove Cutting Tools
3.2.1.3 Operation	3.2.2.3 Select Rotational Speed	3.2.3.3 Cut Size	3.2.4.3 Set up Measuring Instrument	3.2.5.3 Remove Cutting Bits, Pieces
3.2.1.4 Dangers and Safety Measures	3.2.2.4 Turning Procedure, Cut Size	3.2.3.4 Cutting Procedure	3.2.4.4 Measuring Procedure	3.2.5.4 Clean Machine and Tools
3.2.1.4 Tools and Cutters	3.2.2.5 Measuring Procedure	3.2.3.5 Measurements	3.2.4.5 Recording, Recommendation	3.2.5.5 Put Away Tools

KNOWLEDGE: OHS. Lathe function, construction and operating procedures. Operation of a lathe, rotational speed selection. Automatic feed and progression. Size of cut - material removed in a single rotation. Effects of cut size. Basic Calculations: rotational speed and peripheral velocity in terms of cutting speed. Use of callipers and dividers. Measurements and their significance. Meticulous planning and execution of the task. The necessary measurements to be taken during operation. Tolerances.

SKILLS: Select cutter and tools for specific task, handle these safely and correctly, operate the lathe to execute the assignment according to procedure and safety measures, take accurate measurements and record them.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Language; dimensions; micro dimensions and applications. Clearances, Tolerances, Tight fit, Interference fit, Shrink fit, coefficient of expansion in different materials. Calculations. Radian measure. Angular velocity.

MS2 - 3.3 MILLING MACHINE

February 2011

Unit Standard Outcomes: Learner can select the cutter and tools for the specific job, know their basic functions, properties and operations.
Learners can select the correct instruments for the specific measurement, handle them correctly and safely and obtain a correct reading within tolerances.
Learners can motivate their choices verbally and in writing using grammatically correct language and spelling.
Learners can operate the milling machine according to OHS, operating procedures and meticulously execute the assignment.
Learners can do the basic calculations relevant to the tasks.

Curriculum Outcomes: Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension .
Demonstrate ability to plan and execute assignments effectively complying with OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Use science and technology effectively and critically, showing responsibility towards the environment and the health of others.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: Language: speak, read and write. Mechanics: dimensions, and micro dimensions. Basic calculations. Vernier and depth micrometer measurements.

Learner Activities: Active participation: operate a milling machine to execute a specific assignment. Use callipers and dividers. Take accurate measurements with Vernier and depth micrometer. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on a foundation of existing (prior) knowledge.

3.3 MILLING MACHINE	3.3.2 KEYWAY CUTTING	3.3.3 SURFACE CUTTING	3.3.4 SURFACE FINISHING	3.3.5 CLEANING UP
3.3.1.1 OHS. Functions	3.3.2.1 Aligning Work Piece	3.3.3.1 OHS, Safety, Precautions	3.3.4.1 OHS, Safety, Precautions	3.3.5.1 Remove Work Piece
3.3.1.2 Construction	3.3.2.2 Select, Fit Cutting Tool	3.3.3.2 Select, Fit Cutting Tool	3.3.4.2 Alignment of Work Piece	3.3.5.2 Remove Cutting Tools
3.3.1.3 Operation	3.3.2.3 Select Rotational Speed	3.3.3.3 Operation and Adjustments	3.3.4.3 Select, Fit Surfacing Tool	3.3.5.3 Remove Cutting Bits, Pieces
3.3.1.4 Dangers and Safety Measures	3.3.2.4 Automatic Feed and Adjustment	3.3.3.4 Automatic Feed and Adjustment	3.3.4.4 Automatic Feed and Adjustment	3.3.5.4 Clean Machine and Tools
3.3.1.5 Tools and Cutters	3.3.2.5 Cutting Procedure, Cut Size	3.3.3.5 Cutting Procedure, Cut Size	3.3.4.5 Finishing Procedure	3.3.5.5 Put Away Tools
3.3.1.6 Versatility	3.3.2.6 Measuring Procedure	3.3.3.6 Measuring Procedure	3.3.4.6 Recording, Recommendation	

KNOWLEDGE: OHS. Milling machine function, construction and operating procedures. Operation of a milling machine, rotational and cutting speed selection. Automatic feed and progression. Size of cut - material removed in a single rotation/action. Effects of cut size. Basic Calculations: rotational speed and peripheral velocity in terms of cutting speed and cutter diameter. Measurements and their significance. Meticulous planning and execution of the task. The necessary measurements to be taken during operation. Tolerances.

SKILLS: Select cutter and tools for specific task, handle these safely and correctly, operate the milling machine to execute the assignment according to procedure and safety measures, take accurate measurements and record them.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Language; dimensions; micro dimensions and applications. Clearances. Tolerances. Calculations. Angular velocity. Gear cutting/manufacturing. Parts modification.

MS2 - 4.1 REPLACE ELECTRIC FAN

Unit Standard Outcomes: Learners can replace an electric fan it safely and meticulously according to OHS and manufacturer specifications and procedures.
Learners can test fan and thermo switch operations.
Learners can explain the function and operation of an electric cooling fan system verbally and in writing using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate the required skills by calculated execution of assignments through correctly performing procedure, techniques and specifications.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS, Vehicle Care, MS1-1.2 Hand Tools, Multi Tester. Heat, temperature, electric current flow.

Learner Activities: Active participation: operate a milling machine to execute a specific assignment. Use callipers and dividers. Take accurate measurements with Vernier and depth micrometer. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

4.1.1 COOLING SYSTEM OPERATION	4.1.2 ELECTRIC FAN OPERATION	4.1.3 REPLACE ELECTRIC FAN	4.1.4 WRAPPING UP OPERATIONS
4.1.1.1 Function of Cooling System	4.1.2.1 DC Electric Motor Operation	4.1.3.1 Detach Electric Wiring, Connections	4.1.4.1 Top Up Cooling System to Level, Close
4.1.1.2 Coolant Circulation, Cold, Normal Temp.	4.1.2.2 Fan Operation - Aerofoil Effect, Blade	4.1.3.2 Remove Electric Fan, Fan Cowling	4.1.4.2 Run Engine up to Operating Temperature
4.1.1.3 Water pump Function, Construction	4.1.2.3 Thermo Switch Construction, Operation	4.1.3.3 Check, Clean Radiator Core/Air Passage	4.1.4.3 Check System for Leaks, Defects
4.1.1.4 Pressure Radiator Cap, Function, Operation	4.1.2.4 Fan Electric Circuit	4.1.3.4 Install New/Repaired Electric Fan	4.1.4.4 Prepare Vehicle for Delivery
4.1.1.5 Engine Temperature Control, Thermostat	4.1.2.5 Electric Circuit Tests	4.1.3.5 Fit New Thermo Switch	4.1.4.5 Clean Up Work Area, Equipment, Tools
4.1.1.6 Effects of Temperature on Engine Wear	4.1.2.6 Vehicle Movement and Operation	4.1.3.6 Check Operation of Fan and Switch	

KNOWLEDGE: OHS. Function construction and operation of the cooling system components. Effect of the shape of fan blades on airflow. Temperature, heat relationship. Operating temperature of vehicles, pressurised cooling systems, pressure and boiling point. Composition of coolant and contribution of additives. Heat capacities of water and additives. Effect of composition on heat capacity of coolant. Heat transfer: radiation, conduction and convection. Heat conduction of coolant. Effect of heat conducting ability of coolant on engine cooling. Heat conduction, heat dissipation and temperature control. Language, basic chemistry, calculation of resultant heat capacity of mixture. Electricity, magnetism and motor operation. Source of electricity for fan motor.

SKILLS: Safety procedures. Test the operation of an electric fan and thermo switch. Replace electric fan. Vehicle care. Prepare vehicle for delivery and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-7.2: Results of Combustion. Temperature limits of engine parts. Energy loss: exhaust gasses, cooling, cooling system operation, auxiliaries. Calculation of heat capacity of engine coolant. Effects of overheating and overcooling on engine wear. Composition of thermostat materials and their characteristics. Testing of thermostat. Heat and temperature. Techniques to convert low intensity heat into high intensity (temperature) heat. Engine operation and air conditioner (cooling) operation. DC motors and generators, magnetism and induction. The effect of fan operation on available power for vehicle propulsion.

MS2 - 4.1 REPLACE BELT DRIVEN COOLING FAN

February 2011

Unit Standard Outcomes: Learners can replace belt driven fan safely and meticulously according to OHS and manufacturer specifications and procedures.
Learners can replace the fan belt and adjust tension according to specifications and procedure.
Learners can explain the function, construction and operation of a viscous fan drive and write a report on the features using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the required skills by calculated execution of assignments through correctly performing procedure, techniques and specifications.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS, Vehicle Care. MS1-1.2 Hand Tools. Cooling system operation, energy loss. Language, basic mathematics, mechanics, basic physics - energy, conversion into other forms. Engine temperature control.

Learner Activities: Active participation: operate a milling machine to execute a specific assignment. Use callipers and dividers. Take accurate measurements with Vernier and depth micrometer. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

4.2.1 VISCOUS FAN DRIVE	4.2.2 COOLING FAN CHARACTERISTICS	4.2.3 REPLACE VISCOUS FAN	4.2.4 WRAPPING UP OPERATIONS
4.2.1.1 Function, Construction and Operation	4.2.2.1 Aerofoil Effect, Blade Design	4.2.3.1 Remove Fan Belt	4.2.4.1 Top Up Cooling System to Level, Close
4.2.1.2 Energy Consumption of Cooling Fan	4.2.2.2 Improved Air Flow by Blade Design	4.2.3.2 Remove Drive and Fan	4.2.4.2 Run Engine up to Operating Temperature
4.2.1.3 Methods to Reduce Energy Consumption	4.2.2.3 Fan Contribution to Vehicle Noise Levels	4.2.3.3 Prepare for Assembly	4.2.4.3 Check Fan Drive Operation
4.2.1.4 Energy Consumption of Viscous Fan	4.2.2.4 Reduced Noise by Blade Design	4.2.3.4 Fit (New) Drive and Fan	4.2.4.4 Prepare Vehicle for Delivery
4.2.1.5 Viscous Fluid Flow Control	4.2.2.5 Vehicle Movement and Fan Operation	4.2.3.5 Replace Fan Belt, Adjust Tension	4.2.4.5 Clean Up Work Area, Equipment, Tools
		4.2.3.6 Check Operation of Fan	

KNOWLEDGE: OHS. Function, construction and operation of viscous fan drive. Fluid flow control. Effect of the shape of fan blades on airflow and fan noise. How energy is saved with viscous drive - fan operates only when needed. Fan belt tension adjustment, specification and/or tension gauge.

SKILLS: Safety procedures. Replace viscous drive and fan. Remove and fit fan belt and adjust tension. Vehicle care. Prepare vehicle for delivery and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-6.6. MS1-6.8. Transfer of kinetic energy through fluid.

MS2 - 4.3 REPLACE THERMOSTAT

Unit Standard Outcomes: Learners can replace a thermostat safely and meticulously according to OHS and manufacturer specifications and procedures.
Learners can explain the composition of coolant and give the reasons for coolant additives.
Learners can explain the function and operation of a thermostat and write a report on their experiences using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the required skills by calculated execution of assignments through correctly performing procedure, techniques and specifications.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS, MS1-1.2 Hand Tools, Vehicle Care. Language, Basic Mathematics, Mechanics, Basic Physics - energy, temperature and heat.

Learner Activities: Active participation: Operate a milling machine to execute a specific assignment. Use callipers and dividers. Take accurate measurements with Vernier and depth micrometer. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

4.3.1 VEHICLE PREPARATION, PROCEDURE	4.3.2 THERMOSTAT FEATURES	4.3.3 REPLACE THERMOSTAT	4.3.4 WRAPPING UP OPERATIONS
4.3.1.1 Procedure, Select Equipment, Tools	4.3.2.1 Function, Necessity of Temp Control	4.3.3.1 Remove Radiator, Bypass Hoses	4.3.4.1 Mix Coolant according to Specification
4.3.1.2 Drain Coolant to Below Thermostat Level	4.3.2.2 Construction, Operation	4.3.3.2 Unscrew Bolts and Remove Thermostat	4.3.4.1 Refill the Cooling System to Level, Close
4.3.1.3 Examine, Test Coolant, Write Report	4.3.2.3 Operating Temperature, Specification	4.3.3.3 Clean Surfaces, Check for Corrosion	4.3.4.2 Run Engine up to Operating Temperature
4.3.1.4 Procedure Plan, Sequence of Demounting	4.3.2.4 Coolant Circulation Hot and Cold	4.3.3.4 Fit Thermostat, New Packing(s)	4.3.4.3 Check System for Leaks, Defects
4.3.1.5 Examine Fan Belt and Fan/Electric Fan	4.3.2.5 Thermostat in High Pressure Systems	4.3.3.5 Replace Radiator, Bypass Hoses	4.3.4.4 Prepare Vehicle for Delivery
4.3.1.6 Compare New Thermostat with Specifications	4.3.2.6 Test Thermostat - Opening Temperature	4.3.3.6 Secure Bolts, Hose Clamps	4.3.4.5 Clean Up Work Area, Equipment, Tools

KNOWLEDGE: OHS. Function and operation of the thermostat. Heat and expansion - expansion material of thermostat. Composition of coolant, dissolved minerals and pH. Functions and contribution of additives. Normal operating temperature, metal protection, lubrication efficiency, performance, operating efficiency. Work report and relevant documentation. Language, basic chemistry, solution, compound, sludge, oil and water.

SKILLS: Safety procedures. Drain coolant, Remove relevant components and radiator. Vehicle care. Prepare vehicle for delivery and park the vehicle.

VALUES: Communication etiquette, respect. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes, execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-7.2: Results of Combustion: Heat, Expansion. Lubrication viscosity and viscosity index. Effect of temperature on lubricant, metals, engine parts, melting points. Combustibility/flammability of aluminium (pistons). Chemical reactions between acids and metals, between alkalis and metals and the importance of neutral pH.

MS2 - 4.4 REPLACE WATER PUMP

February 2011

Unit Standard Outcomes: Learners can replace a water pump safely and meticulously according to OHS and manufacturer specifications and procedures.
Learners can explain the composition of coolant and give the reasons for coolant additives.
Learners can explain the function and operation of a water pump.
Complete the documentation and write a report on their experiences using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the required skills by calculated execution of assignments through correctly performing procedure, techniques and specifications.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS, MS1-1.2 Hand Tools, Vehicle Care. Language, basic mathematics, mechanics, basic physics - energy, temperature and heat.

Learner Activities: Active participation: read the work procedure from a study guide and workshop manual and the OHS regulations regarding safety. Reflect verbally and write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills, values while demonstrating, discussing water pump and cooling system features.

Theoretical Foundation: Constructivist education - Learners construct their own mental representations of information on existing (prior) knowledge.

4.3.1 VEHICLE PREPARATION, PROCEDURE	4.3.2 WATER PUMP FEATURES	4.3.3 REPLACE WATER PUMP	4.3.4 WRAPPING UP OPERATIONS
4.3.1.1 Procedure, Select Equipment, Tools	4.3.2.1 Function, Necessity Positive Flow	4.3.3.1 Remove Radiator, Bypass Hoses	4.3.4.1 Mix Coolant according to Specification
4.3.1.2 Drain Coolant	4.3.2.2 Construction, Serviceable/Non Serviceable	4.3.3.2 Unscrew Bolts and Remove Water Pump	4.3.4.1 Refill the Cooling System to Level, Close
4.3.1.3 Examine, Test Coolant, Write Report	4.3.2.3 Operation, Centrifugal Pump	4.3.3.3 Clean Surfaces, Check for Corrosion	4.3.4.2 Run Engine up to Operating Temperature
4.3.1.4 Procedure Plan, Sequence of Unmounting	4.3.2.4 Coolant Circulation Hot or Cold	4.3.3.4 Fit Water pump, New Packing(s)	4.3.4.3 Check System for Leaks, Defects
4.3.1.5 Remove Fan Belt and Fan/Components	4.3.2.5 Water Pump vs. Convection Current	4.3.3.5 Replace Radiator, Bypass Hoses	4.3.4.4 Prepare Vehicle for Delivery
		4.3.3.6 Secure Bolts, Hose Clamps	4.3.4.5 Clean Up Work Area, Equipment, Tools

KNOWLEDGE: OHS. Function and operation of the water pump. Centrifugal force and water pump impeller design. Circulation of coolant through the system, cold and hot. Need for continuous circulation. Uneven temperatures in the engine, hottest parts. Work report and relevant documentation. Language, basic chemistry, solution, compound, sludge, oil and water.

SKILLS: Safety procedures. Handling of hand tools. Drain coolant. Procedure to remove relevant components. Vehicle care. Prepare vehicle for delivery and park the vehicle.

VALUES: Communication etiquette, respect, empathy. Personal and people health and safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: MS1-6.6; MS2-4.1, 4.2, 4.3: Heat, expansion and convection circulation. Heat conduction capacity of water and coolant additives. Additives to improve heat conduction.

MS2 - 5.1 REPLACE MACPHERSON STRUTS

Unit Standard Outcomes: Learners can replace MacPherson struts according to manufacturer's procedure and complying to OHS.
Learners can explain verbally and in writing the operation of the suspension - wheel movement in relation to vehicle body.
Learners can explain verbally and in writing the operation of the steering action of the suspension - pivot, knuckles and joints.
Learners can write a report, reflect on their experiences verbally and in writing.

Curriculum Outcomes: Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (fitment centres).

Knowledge Foundation: MS1-1.1 OHS, Vehicle Care, MS1-1.2 Hand Tools, MS1-2.2 Vehicle Hoist, MS1-2.5 Trolley Jack, MS1-6.2 Shock Absorbers. Language, basic mathematics, basic physics - kinetic energy, heat energy, conversion of.

Learner Activities: Learners put a vehicle on a hoist/lift with trolley jack. Replace MacPherson struts according to the procedure. Take notes of information provided, reflect verbally and write a report on the experiences and information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating procedures and discussing tyre grip and vehicle control.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

5.1.1 PREPARATION	5.1.2 DISMANTLING PROCEDURE	5.1.3 ASSEMBLING PROCEDURE	5.1.4 WRAPPING UP
5.1.1.1 OHS, Dismantling Procedures	5.1.2.1 Detach Brake Calliper	5.1.3.1 Prepare for Mounting Procedure	5.1.4.1 Check Steering, Brake Operation
5.1.1.2 Select Equipment, Tools	5.1.2.2 Detach Driving Shafts	5.1.3.2 Mount Springs and Spindles - L and R	5.1.4.2 Mount Wheels
5.1.1.3 Avoid Brake Fluid Spillage	5.1.2.3 Detach Steering Rod Ends	5.1.3.3 Attach Strut Assembly to Vehicle	5.1.4.3 Lowering Procedure
5.1.1.4 Lift, Secure Vehicle	5.1.2.4 Detach Hub Assemblies from Struts	5.1.3.4 Attach Hub Assemblies to Struts	5.1.4.4 Check Suspension Operation
5.1.1.5 Remove Wheel Trimmings	5.1.2.5 Detach Strut Assembly and Remove	5.1.3.5 Attach Steering Rod Ends	5.1.4.5 Prepare Vehicle for Delivery
5.1.1.6 Remove Wheels	5.1.2.6 Check Colour Codes on Springs, L and R	5.1.3.6 Attach Driving Shafts	5.1.4.6 Clean Tools and Work Area
	5.1.2.7 Remove Suspension Springs from Struts	5.1.3.7 Attach Brake Callipers	5.1.4.7 Put Away Tools and Equipment

KNOWLEDGE: OHS. For lifting only one end of vehicle, allow for jack and vehicle wheels to roll. Function, construction and operation of suspension. Function construction and operation of shock absorbers. The basic factors determining suspension efficiency: spring elasticity, shock absorber resistance. Vehicle mass, spring tension, colour coding. Forces, momentum and reactions - magnification of forces by speed. Work report and relevant documentation. Language, physics, mechanics.

SKILLS: Safety procedures. Lifting and securing a vehicle. Remove wheels, check for damage and wear on suspension components. Replace suspension struts. Vehicle care. Remove vehicle from the trestles and parking the vehicle.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions and execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Science: friction, kinetic energy, heat. Kinetic energy "absorption" - converting kinetic energy into heat, forcefully displace liquid from one chamber to another (controlled flow). Mechanics: force, momentum, acceleration. Language: spelling, sentence structure, expressions.

MS2 - 5.2 GEARBOX REMOVAL Front Wheel Drive

February 2011

Unit Standard Outcomes: Learners can read safety rules, the gearbox removal procedures from study guides and/or manuals.
Learners can select the correct tools and equipment and follow the correct procedure to remove the gearbox from the vehicle.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.
Learners can explain basic gearbox operation, do calculations: Math/Mechanics: ratios, force, and torque.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Communication. Science, Technology. Information
Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety, MS1-1.2 Tools, MS1-2.2 Vehicle Hoist, MS1-2.4 Gearbox Jack. MS1-6.1 Vehicle Layout. MS1-7.1 Remove Starter. MS1-7.3 Remove Gearbox RWD. MS1-8.5 Gear Drives. Language.

Learner Activities: Active participation: put vehicle on lift, detach and remove gearbox. Prepare gearbox for dismantling. Take notes of information provided, reflect verbally, write a report on the information and proceedings

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

5.2.1 PREPARATION	5.2.2 REMOVE CONTROLS and MONITORS	5.2.3 UNMOUNT, REMOVE GEARBOX	5.2.4 WRAPPING UP OPERATIONS
5.2.1.1 Procedure Plan (Manual/study Guide)	5.2.2.1 Detach Driving Shafts	5.2.3.1 Unscrew Mounting Bolts	5.2.4.1 Mount Gearbox on a Gearbox Stand
5.2.1.2 Site Preparation	5.2.2.2 Detach Gear Lever	5.2.3.2 Support Engine with Jack and Cradle	5.2.4.2 Clean Gearbox
5.2.1.3 Select Equipment and Tools	5.2.2.3 Detach Wiring	5.2.3.3 Unscrew Gearbox Bolts Except One at Top	5.2.4.3 Clean, Put Away Tools and Equipment
5.2.1.4 Lift Vehicle with Hoist, Secure	5.2.2.4 Detach Speedometer Drive	5.2.3.4 Secure Gearbox on Gearbox Jack	5.2.4.4 Put Away, Secure Vehicle Components
5.2.1.5 Drain Lubricant	5.2.2.5 Detach Clutch Cable/Pipe	5.2.3.5 Remove Remaining Bolt	5.2.4.5 Clean Worksite
5.2.1.6 Clean Gearbox, Body Area	5.2.2.6 Remove Starter	5.2.3.6 Slide Gearbox in a Straight Line out of Clutch	5.2.4.6 Prepare Vehicle for Mounting Gearbox
5.2.1.7 Load vs Jack Capacity		5.2.3.7 Lower Gearbox Jack	5.2.4.7 Report Damages and Defects in Writing

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Gearbox-final drive assembly, functions, construction. Function of final reduction. Function and operation of differential. Gear ratios and speed calculations. Gear ratios and torque calculations. Compare sacrifice of speed and torque gain. Safety, procedures and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures. Remove gearbox from vehicle.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mathematics: arithmetic, manipulation of formula. Mechanics: gears and ratios, compilation of formula for torque and speed calculations. Simplification of formula - eliminating redundant elements.

S2 - 5.3 GEARBOX INSTALLMENT Front Wheel Drive

February 2011

Unit Standard Outcomes: Learners can read safety rules and the gearbox mounting procedures from study guides and/or manuals.
Learners can select the correct tools and equipment and follow the correct procedure to mount the gearbox in the vehicle.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.
Learners can explain drive train and CV joint operation.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.

Critical Outcomes: Communication. Science, Technology. Information
Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety, MS1-1.2 Tools, MS1-2.2 Vehicle Hoist, MS1-2.4 Gearbox Jack. MS1-6.1 Vehicle Layout. MS1-7.1 Remove Starter. MS2-5.2 Remove Gearbox. MS1-8.5 Gear Drives. Language.

Learner Activities: Active participation: put vehicle on lift and mount gearbox in vehicle. Prepare vehicle for delivery. Take notes of information provided, reflect verbally and write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

5.3.1 PREPARATION	5.3.2 MOUNT GEARBOX	5.3.3 ATTACH CONTROLS and MONITORS	5.3.4 WRAPPING UP OPERATIONS
5.3.1.1 Procedure Plan (Manual/study Guide)	5.3.2.1 Secure Gearbox on Gearbox Jack	5.3.3.1 Mount Starter	5.3.4.1 Fill Gearbox with Prescribed Lubricant
5.3.1.2 Site Preparation Tool Table etc.	5.3.2.2 Lift Gearbox and Align with Clutch Plate	5.3.3.2 Grease CV Joints and Attach Driving Shafts	5.3.4.2 Check Gearlever Operation
5.3.1.3 Select Equipment and Tools	5.3.2.2 Slide Gearbox in a Straight Line into Clutch	5.3.3.3 Attach Gear Lever	5.3.4.3 Check Smooth Selection of Gears
5.3.1.4 Lift Vehicle with Hoist, Secure	5.3.2.3 Screw in Bolts (one at top) to Guide Gearbox	5.3.3.4 Attach Wiring	5.3.4.4 Check Clutch Operation
5.3.1.5 Clean Gearbox, Body Area	5.3.2.5 Screw in Remaining Bolts	5.3.3.5 Attach Speedometer Drive	5.3.4.5 Prepare Vehicle for Delivery
5.3.1.6 Check Load vs Jack Capacity	5.3.2.6 Fasten Gearbox Mounting	5.3.3.6 Attach Clutch Cable/Pipe	5.3.4.6 Clean, Put Away Tools and Equipment
	5.3.2.7 Remove Jack and Cradle Underneath Engine	5.3.3.7 Check Clutch Adjustment	5.3.4.7 Clean Worksite

KNOWLEDGE: OHS. Tools and equipment, purposes, use. How gearbox input shaft fits into clutch plate. Detrimental effects of misalignment when mounting a gearbox. CV joint functions, construction and operation. Reasons for equipping vehicles with CV joints. Reasons for special lubricant for CV joints. Safety, procedures, and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures. Mount gearbox in vehicle. Vehicle care and delivery preparation.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Construction and operation of Hooke type universal joints. Limitations of Hooke type universal joints. Speed fluctuation of Hooke type universal joints, reason for acceleration and deceleration of driven piece of driving shaft during every 180°. Negative effects of speed fluctuation. Effect of wheel (tyre) diameter on vehicle speed and performance. Torque on wheels converted into propulsion. Power in terms of linear movement.

MS2 - 5.4 MOUNT ENGINE IN VEHICLE

February 2011

Unit Standard Outcomes: Learners can select the correct tools and equipment and follow the correct procedure to mount the engine in the vehicle.
Learners can mount the support components in the vehicle and connect them correctly.
Learners can explain the procedures verbally and in writing using grammatically correct language and spelling, do mathematical and mechanics calculations.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Communication. Science, Technology. Information
Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety, MS1-1.2 Tools, MS1-2.3 Engine Hoist, MS1-6.1 Vehicle Layout. MS1-6.5, MS1-6.6, MS1-6.7, MS1-6.8, MS1-7.1. Trigonometry. Mechanics. Language.

Learner Activities: Active participation, mount engine. Mount support components. Calculate resultant forces in sling, leverage of engine hoist, pressure in cylinder to produce resultant force to lift engine. Take notes of information provided, reflect verbally, write a report on the information and proceedings

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Transdisciplinary integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

5.4.1 PREPARATION PLAN	5.4.2 MOUNT ENGINE	5.4.3 REPLACE SUPPORT COMPONENTS	5.4.4 WRAPPING UP OPERATIONS
5.4.1.1 Procedure Plan, Site Preparation	5.4.2.1 Lower Engine onto Mountings	5.4.3.1 Mount Radiator	5.4.4.1 Top Up Battery Electrolytes
5.4.1.2 Lay Out Tools and Equipment	5.4.2.2 Fasten Engine Mountings	5.4.3.2 Fit Radiator Hoses, Bypass Hose	5.4.4.2 Put Lubricant into the Engine
5.4.1.3 Vehicle Preparation	5.4.2.3 Push Gearbox in Straight Line into Clutch	5.4.3.3 Fit Heater, Vacuum Hoses	5.4.4.3 Fit New Oil Filter
5.4.1.4 Engine Preparation	5.4.2.4 Use two Guide Bolts (one at top) Mount Gearbox	5.4.3.4 Mount Alternator	5.4.4.4 Put Coolant into the Radiator
5.4.1.5 Hook Engine onto Engine Hoist	5.4.2.5 Remove Gearbox Support and Engine Hoist	5.4.3.5 Attach Fuel Supply System	5.4.4.5 Top Up Gearbox Lubricant
5.4.1.6 Determine Sling Angles*	5.4.2.6 Mount Starter	5.4.3.6 Attach Control Linkages	5.4.4.6 Prepare Engine for Starting
5.4.1.7 Calculate Forces in Sling	5.4.2.7 Attach Exhaust Pipe	5.4.3.7 Attach Wiring	5.4.4.7 Clean, Put Away Tools and Equipment
5.4.1.8 Determine Sling Strength	5.4.2.8 Attach Clutch Cable/Fluid Line	5.4.3.8 Replace Battery	5.4.4.8 Clean Worksite
5.4.1.9 Take Up Engine Mass with Hoist	5.4.3.9 Adjust Clutch Pedal Free Travel	5.4.3.9 Attach Battery Positive (first), Earth	*Avoid too small Sling Angles - Excessive Forces

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Engine components, functions, care. Weight, force, mass and vector diagram. Engine weight (downward force) in relation to engine hoist support points (wheels). Procedure and techniques to mount gearbox on engine and engine in vehicle. Safety, procedures and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures of mounting gearbox on engine, engine in vehicle and support components.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Engine operation MS2-7.2. Mechanics: forces and torque. Mathematical calculation of forces in sling. Calculation of hydraulics pressure and resulting forces on piston. Pump plunger-piston diameter ratio, force-load ratio. Mathematics: arithmetic, algebra, trigonometry.

Unit Standard Outcomes: Learners can read safety rules, the final drive mounting procedures from study guides and/or manuals and reflect on these.
Learners can "read" the sketches from the manual; explain the construction of the rear axle assembly and the sequence of replacing components.
Learners can select the correct tools and equipment and follow the correct procedure to mount the final drive in the vehicle.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Communication. Science, Technology. Information
Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as member of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety, MS1-1.2 Tools, MS1-2.2 Vehicle Hoist, MS1-2.4 Gearbox Jack. MS1-6.1 Vehicle Layout. MS1-5.5 Final Drive Removal. Language.

Learner Activities: Active participation: mount final drive. Take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing – learners acquire knowledge, skills and values while working with their hands. Transdisciplinary integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

5.5.1 PREPARATION PLAN	5.5.2 MOUNT CENTREPIECE	5.5.2 REPLACE PARTS, REAR WHEELS	5.5.4 WRAPPING UP OPERATIONS
5.5.1.1 Procedure Plan (Manual/Study Guide)	5.5.2.1 Secure Centrepiece on Gearbox Jack	5.5.2.1 Slide Side Shafts into Centrepiece, Mount	5.5.4.1 Fill Final Drive with Prescribed Lubricant
5.5.1.2 Lay Out Tools and Equipment	5.5.2.2 Attach Centre Piece Packing	5.5.2.2 Assemble Rear Brake Systems	5.5.4.2 Check Operation of Brakes
5.5.1.3 Prepare Vehicle for Assembly	5.5.2.3 Slide Centrepiece into Housing	5.5.2.3 Fit Brake Drums, Adjust Brakes, Handbrake	5.5.4.3 Check Operation of Handbrake
5.5.1.4 Prepare Final Drive Housing	5.5.2.4 Screw Bolt into Housing - One at Top	5.5.2.4 Attach Driving Shaft from Final Drive	5.5.4.4 Clean, Put Away Tools and Equipment
5.5.1.5 Get Lubricant Specifications	5.5.2.5 Screw in Remaining Bolts, Tighten All	5.5.2.5 Mount Rear Wheels	5.5.4.5 Clean Worksite
5.5.1.6 Prepare Different Parts for Assembly	5.5.2.6 Lower Gearbox Jack		

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Safety, procedures and recording. Disadvantage of differential. Hypoid gear arrangement. Higher quality lubricant requirement of hypoid gears. Calculation of ratio of hypoid gears.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures. Dismantling rear brake assemblies, remove side shafts and centrepiece.

VALUES: Communication etiquette, respect for and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Engine speed, gearbox input and output speeds, final drive input speed. Gear teeth strength - small vs big. Engine torque, ratios and rear wheel torque. Propulsion force. Final drive tooth contact patterns and effects. Definition of viscosity and viscosity vs. quality. Quality specifications. Extreme pressure characteristics of lubricants.

MS2 - 6.1 LUBRICATION SERVICE

February 2011

Unit Standard Outcomes: Learners can locate and identify engine filters, describe functions in relation to engine operation and motivate the needs of lubrication services.
Learners can replace filters, engine oil, and dispose of filters and oil in the prescribed manner.
Learners can do the inspections and write a report according to the procedure.
Learners demonstrate appreciation of property, tidiness, and interpersonal relationships.

Curriculum Outcomes: Learning. Communication. Knowledge, skills, values
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, correct and safe handling of tools and equipment and prescribed procedure.
Demonstrate capacity to operate in real world (workplace) environments and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.
Demonstrate the ability to diagnose systematically, identify defects and propose feasible solutions.

Critical Outcomes: Communication. Science, Technology. Information
Communicate effectively using visual, symbolic and/or language skills in various modes.
Organise and manage themselves and their activities responsibly and effectively.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS, MS1-1.2 Hand Tools, MS1-2.2 Vehicle Hoist, MS1-5.1 Vehicle Layout, Cooling System Maintenance: MS1-4.1, 4.2, 4.3, 4.4.

Learner Activities: Execute a lubrication service on a vehicle, take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while executing a lubrication service and discussing procedures. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

ENGINE LUBRICATION	DRIVE TRAIN COMPONENTS, COOLING SYSTEM, LATCHES	INSPECTION AND REPORT
6.1.1 Site Preparation: Clean, Arrange work surfaces, Hoist, Container	6.1.8 Lubricant Levels: Gearbox, Final Drive, Power Steering, Hydraulics	6.1.14 Air and Fuel Filters: Replacement Schedule, Inspection
6.1.2 Procedure: Study OHS, Service Guide, Precautions, Inspections	6.1.9 Brake Fluid Level: Specification (Quality), Top-up Precaution, Level	6.1.15 Liquid Leaks: Brakes, Coolant, Gearbox, Diff, etc.
6.1.3 Tools Selection: Hand, Special Tools, Funnel	6.1.9 Wearing Surfaces Lubrication: Striker Plates, Latches	6.1.16 Shock Absorbers: Leaks, Damage, Rubbers
6.1.4 Lubrication: Oil Contamination, Check: Metal Particles, Water	6.1.10 Coolant Quality and Level: Contamination, pH Check, Additive	6.1.17 Driving Shafts: Boots, Grease Spillage,
6.1.5 Filters: Replacement Schedule, Type, Procedure	6.1.11 Cooling Components: Fan, Fan Belt, Water Pump, Thermostat	6.1.18 Tyres: Tread Depth, Cracks, Cuts, Bubbles
6.1.6 Oil Qualities: Classification API, SAE; Selection, Quantities	6.1.12 Belt Drives: Inspection: Cracks, Tension, Pulleys	6.1.19 Lights: All in Working Condition, Report Defects
6.1.7 Refill Procedure: Filter Capacity, Level, Leak Inspection	6.1.13 Battery Care (6.2): Clean Battery, Check Electrolyte Level, Top up.	6.1.20 Cleaning Up: Vehicle, Work Area, Tools, Equipment

KNOWLEDGE: Lubrication principles and temperature control. Viscosity and temperature. Lubricant classification, coolant additive function, classification, motivation for frequent services, OHS.

SKILLS: Safety procedures, vehicle care, handling of tools and equipment. Service procedures, inspection procedures.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: 1.1; 1.2; 2.3; 5.1; 4.1; 8.5; 7.2 Engine operation. Mechanics: force and torque. Science: friction, lubricants, heat. Lubrication qualities, SAE, API and manufacturer grading. Chemistry of oil. Mathematics: arithmetic, trigonometry, LCM. Gears.

Unit Standard Outcomes:	Learners can service a battery according to procedure and compliance with safety rules. Learners can provide information about battery care and optimising battery life. Learners can do the inspections and write a report according to the procedure. Learners demonstrate appreciation of property, tidiness, and respect, empathy, honesty, dedication.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure. Demonstrate capacity to operate in real world (workplace) environments and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals. Demonstrate the ability to diagnose systematically, identify defects and propose feasible solutions.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Organise and manage themselves and their activities responsibly and effectively. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: 1.1 OHS, 1.2 Hand Tools, 5.1 Vehicle Layout, 6.7 Battery Removal. Language, arithmetic, atom theory

Learner Activities: Execute a lubrication service on a vehicle, take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while executing a lubrication service and discussing procedures.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

6.2.1 PROCEDURE AND OHS STUDY	6.2.2 BASIC BATTERY STRUCTURE	6.2.3 CLEANING BATTERY	6.2.6 BATTERY FEATURES
6.2.1.1 Battery Principle	6.2.2.1 Battery Construction	6.2.3.1 Remove Chemical Deposits, Neutralise Acid	6.2.6.1 Voltage, Current, Power, Capacity
6.2.1.2 Chemicals, Composition Basics, Atoms	6.2.2.2 Chemicals	6.2.3.2 Washing Procedure, Drying	6.2.6.2 Battery Pairs and Packs
6.2.1.3 Electron, Conventional Current Flow	6.2.2.3 Basic Chemical Reactions, By-Products	6.2.4 EXTERNAL INSPECTION	6.2.6.3 Volt, Capacity Calculations
6.2.1.4 Conductors, Isolators, Resistors	6.2.2.4 External, Internal Current Flow, Polarity	6.2.4.1 Box, Lid, Caps	6.2.6.4 Battery Life, Max Full Cycles
6.2.1.5 Resistance, Heat and Power (Loss)	6.2.2.5 External, Internal Resistances	6.2.5 INTERNAL INSPECTION	6.2.7 CHARGING PROCEDURE
6.2.1.6 PD, EMF, Amps and Watt	6.2.2.6 Battery Capacity AH Rating	6.2.5.1 Electrolyte, RD	6.2.7.1 Charging Rate
6.2.1.7 Elementary Circuits, Calculations	6.2.2.7 Dangers of Reversed Polarity	6.2.5.2 Plates, Separators	6.2.7.2 Rate of Charge
6.2.1.8 Current Requirements of Components	6.2.2.8 Battery Care, Optimise Battery Life		6.2.8 CLEANING UP

KNOWLEDGE: OHS. Tools, purposes, use. Battery function, construction, operation. Acid, how to neutralise. charging/discharging, by-products, dangers. Relative density, hydrometer, electrolyte RD and state of charge. Rate of discharge and charge. Voltage and capacity when connecting batteries in series or parallel.

SKILLS: Safety procedures, vehicle care, handling of tools and equipment. Service procedures, inspection procedures.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools. Tidiness, respect, empathy, honesty, dedication.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Chemistry, Physics, Atomic Structures, Electrical Charges. Chemical reactions when charging and discharging. External, internal current flow. External, internal resistance. Motor vehicle batteries, low current output batteries. Voltage drop during starting - PD and EMF.

MS2 - 7.1 ENGINE DISMANTLING AND PARTS IDENTIFICATION

February 2011

Unit Standard Outcomes:	Learners can identify parts; know their functions, construction, material and basic properties. Reasons for cooling and lubrication. Learners can select the correct tools and equipment to remove the parts. Learners can follow the correct procedure to remove the parts. Learners can read safety rules, the procedures from study guides and/or manuals and reflect on it. "Read" sketches and exploded views. Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling. Learners can do mathematical, scientific, mechanics calculations related to the operations executed.
Curriculum Outcomes:	Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure. Demonstrate the ability to transfer knowledge from a specific task to differing applications. Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations. Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.
Critical Outcomes:	Identify and solve problems and make decisions using critical and creative thinking. Organise and manage themselves and their activities responsibly and effectively. Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: Safety 1.1, Tools 1.2, Engine Hoist 2.3, Vehicle Layout 5.1, Metal Knowledge 4.1, Lubrication 6.1. Arithmetic, formula, language

Learner Activities: Active participation, take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

7.1.1 SITE PREPARATION AND PLAN	7.1.2 ENGINE PREPARATION	7.1.3 DISMANTLING PROCEDURE	7.1.4 TOOLS AND EQUIPMENT
7.1.1.1 Cleanliness	7.1.2.1 Cleanliness	7.1.3.1 Consult Safety Procedures	7.1.4.1 Selection of tools
7.1.1.2 Appropriateness	7.1.2.2 Drain Liquids	7.1.3.2 Consult Manual/Study Guide	7.1.4.2 Selection of Equipment
7.1.1.3 Space and freedom of movement	7.1.2.3 Remove Filters	7.1.4.3 Reflect on Information Gathered	7.1.4.3 Motivate Choices
7.1.5 MAIN COMPONENTS/PARTS	7.1.6 PARTS, CONSTRUCTION, MATERIAL	7.1.6.5 Damage/wear reasons	7.1.7 FUNCTION, FEATURES
7.1.5.1 Precise selection and handle tools	7.1.6.1 Construction/design features	7.1.6.6 Verbal, Written reflections	7.1.7.1 Functions fundamental to operation
7.1.5.2 Exhibit procedure competence	7.1.6.2 Material features and reasons	7.1.6.7 Mathematics, Science, Mechanics	7.1.7.2 Basics of Operation
7.1.5.3 Explain Procedure, Safety, Reason	7.1.6.3 Lubrication	7.1.6.8 Written report on condition of parts	7.1.7.3 Related maths, mechanics, science
7.1.5.4 Safe handling and care	7.1.6.4 Cooling: Heat, Temperature, etc.	and experience	7.1.7.4 Sketches, Exploded Views

KNOWLEDGE: OHS. Tools, purposes, use. Engine parts, functions, constructions, role of lubrication and cooling, care. Weight, force, mass and pressure. Heat, temperature, energy, measurements and calculations. Safety, procedures, acquisition and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution of procedures.

VALUES: Communication etiquette, respect and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Engine operation 7.2. Mechanics: force and torque. Science: friction, lubricants, heat. Mathematics: arithmetic, trigonometry, LCM. Gears.

MS2 - 7.2 ENGINE OPERATION, SI AND CI

Unit Standard Outcomes: Learners can identify engine parts and describe functions in relation to engine operation.
Learners can explain the engine operating cycles verbally and in writing using grammatically correct language and spelling, using sketches, drawings.
Learners can explain the relationships between heat, temperature, pressure, volume, energy, combustion, force, moments (torque), power.
Learners can do mathematical, scientific and mechanics calculations related to the operations.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations.
Demonstrate capacity to perform the mathematical and scientific procedures involved in the projects.

Critical Outcomes: Communication. Science, Technology. Information
Communicate effectively using visual, symbolic and/or language skills in various modes.
Use science and technology effectively and critically.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 Safety, MS2-7.1 Engine parts. Engine construction. Crank through, piston stroke. Basic trigonometry, manipulation of formula, arithmetic, formula manipulation, language.

Learner Activities: Active participation, take notes of information provided, reflect verbally, write a report on the information and proceedings

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while manipulating engine components and discussing procedures. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

7.2.1 SI Operating Cycle, Four Stroke	**7.2.2** Science and Mechanics of Engines	**7.2.3** CI Operating Cycle, Four Stroke	7.2.3.10 Efficiency
7.2.1.1 Piston Movement and "Stroke"	7.2.2.1 Gas Pressure	7.2.3.1 Gas Pressure vs. Temperature	7.2.3.11 Pressure, Force, Moments, Torque, Power
7.2.1.2 Operation of the Valves	7.2.2.2 Gas Laws (Boyle)	7.2.3.2 Heat, Temperature and Energy	7.2.3.12 Connecting Rod Angles and Torque
7.2.1.3 Crank Rotation, Throw and "Stroke"	7.2.2.3 Energy	7.2.3.3 Pressure Changes During Cycle	
7.2.1.4 Gas Flow	7.2.2.4 Pressure, Temperature Changes	7.2.3.4 Ignition	**7.2.4** Two Stroke Cycles
7.2.1.5 Compression, Reasons and Energy Loss	7.2.2.5 Ignition Basics and Effects	7.2.3.5 Combustion and Control	7.2.4.1 SI Valveless
7.2.1.6 Ignition, Combustion, Energy Release	7.2.2.6 Combustion, Energy Conversion	7.2.3.6 Speed Control	7.2.4.2 SI with Inlet Valves
7.2.1.7 Heat, Expansion, Pressure and Force	7.2.2.7 Speed Control	7.2.3.7 Ignition vs. Engine Speed	7.2.4.3 CI GM (Exhaust Valves Only)
7.2.1.8 Exhaust, Gas Flow, Momentum	7.2.2.8 Ignition vs. Engine Speed	7.2.3.8 Basic Performance Factors	7.2.4.4 Super Charging Basics
7.2.1.9 Complete Cycle	7.2.2.9 Basic Performance Factors	7.2.3.9 Energy Losses	7.2.4.5 Turbo Charging Basics

KNOWLEDGE: OHS. Engine parts, functions, constructions, role of lubrication and cooling, care. Weight, force, mass and pressure. Triangle, parallelogram of forces, basic vector diagram and calculations, trigonometry. Force, moments, torque, power. Temperature, conversion of kinetic energy into heat energy. Conversion of heat energy into kinetic energy. Volume, pressure, temperature. Combustion, chemical reactions, heat release. Safety, operating procedures, acquisition and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures. Relate engine parts to engine operation. Identify metals of different parts.

VALUES: Communication etiquette, respect for and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Combustion Chemical Reactions. Heat Release, Conversion of Heat into Pressure/Force. Heat Intensity and Temperature. Mechanics: force and torque. 90° of crankshaft rotation ≠ 50% of piston stroke. Calculation of engine displacement, compression ratio, volumetric efficiency potential torque. Valve timing diagrams, ignition timing and advance. Indicator diagrams. Science: friction, lubricants, heat. Vector Diagrams. Mathematics: arithmetic, trigonometry, LCM. Gears.

MS2 - 8.1 DOUBLE REDUCTION V-BELT DRIVES

February 2011

Unit Standard Outcomes: Learners can describe the composition, features, dynamics, construction and maintenance of double reduction v-belt drives.
Learners can calculate ratios, belt tensions, forces in both belts and power transmission.
Learners can write a report on the features of double reduction v-belt drives in grammatically correct language.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS. MS1-8.2 V-Belt Drives. Power, torque, force. Arithmetic, manipulation of formula. Language.

Learner Activities: Learners take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while participating in the presentation and discussions. Writing presentation report.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.2.1 COMPOSITION	8.2.2 FEATURES	8.2.3 DYNAMICS	8.2.4 CONSTRUCTION	8.2.5 MAINTENANCE
8.2.1.1 Pulleys	8.2.2.1 Versatility	8.2.2.1 Angle of Contact	8.2.4.1 Belt Structure	8.2.5.1 Slip Control, Belt Dressing
8.2.1.2 Straight Drive arrangement	8.2.2.2 Alignment	8.2.2.2 Friction	8.2.4.2 Belt Materials	8.2.5.2 Belt, Joint Wear
8.2.1.3 Belt Profile	8.2.2.3 Reasons for Double Reduction	8.2.2.3 Belt Tensions	8.2.4.3 Pulley Materials	8.2.5.3 Secure Pulleys on Shafts
8.2.1.4 Bearings, Bushes	8.2.2.4 Advantages and Limitations	8.2.2.4 Power Transmission	8.2.4.4 Pulley fit on Shaft	8.2.5.4 Pulley Wear
8.2.1.5		8.2.2.5 Ratios	8.2.4.5 Keys and Locks	8.2.5.5 Bearings, Bushes

KNOWLEDGE: OHS. Arithmetic, manipulation of formula. Ratio and rotational speed calculations. Mean, slack side, tight side forces. Tight side forces exceed driving force. Differences in forces between two belts and the reasons. Forces acting on bearings. Plan a double reduction v-belt drive. Factors effecting belt drive capacity. Effect of centrifugal force on belt drives. Pulley diameter and centrifugal force. Derive effect of belt speed on efficiency.

SKILLS: Safety procedures. Reading, writing, verbal communication. Utilising sketches, models, charts and relevant symbols to explain characteristics of double reduction v-belt drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mechanics: forces in belts; calculate maximum forces in belts. Science: friction, heat. Mathematics: arithmetic, proportionality, trigonometry for vector calculations. Ratio and rotational speed calculations. Belt speed, centrifugal force and friction force - friction.

Unit Standard Outcomes: Learners can describe the composition, features, dynamics, construction and maintenance of double reduction roller chain drives.
Learners can calculate pitch circle (mean effective) diameters, ratios, forces in both chains and power transmission.
Learners can explain the reasons for the bigger difference in slack side and tight side forces compared to belt drives; the reason for a stronger second chain.
Learners can write a report on roller chain drives using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS. MS1-4.1 Metal Knowledge. Power, torque, force. MS1-8.3 Chain Drives, MS1-8.2 V-belt drives. Mathematics. Mechanics. Language.

Learner Activities: Learners examine a double roller chain drive, discuss it construction, features, dynamics and maintenance. Do the calculations and find further sources of information about chain drives. Take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while examining and discussing chain drives. Transdisciplinary integrated education.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.2.1 ARRANGEMENT	8.2.2 CONSTRUCTION	8.4.3 FEATURES	8.2.3 DYNAMICS	8.2.4 MAINTENANCE
8.4.1.1 Gears (Sprockets)	8.4.2.1 Sprocket Construction	8.4.3.1 Number of Teeth in Contact	8.4.4.1 Positive Drive (No slip)	8.4.5.1 Lubrication
8.4.1.2 Roller Chain	8.4.2.2 Chain Construction	8.4.3.2 Roller Action and Lubrication	8.4.4.2 Chain, Sprocket Contact	8.4.5.2 Wear Specifications/Replace
8.4.1.3 Straight Drive arrangement	8.4.2.3 Chain Materials	8.4.3.3 Chain Stretch vs. Teeth Contact	8.4.4.3 Chain Tensions × 4	8.4.5.3 Gear Wear
8.4.1.4 Links	8.4.2.4 Sprocket fit on Shaft	8.4.3.4 Gear Teeth Strength	8.4.4.4 Power Transmission	8.4.5.4 Secure Pulleys on Shafts
8.4.1.5 Bearings, Bushes, Supports	8.4.2.5 Keys, Splines and Locks	8.4.3.5 Alignment	8.4.4.5 Ratios	8.4.5.5 Bearings, Bushes

KNOWLEDGE: OHS. Arithmetic, manipulation of formula. Derive ratio formula from first principles - no formula given. Ratio and rotational speed calculations - differences in shaft speeds. Tensile strength, slack side, tight side forces. Pitch circle diameter. Driver and driven sprockets.

SKILLS: Safety procedures. Reading, writing summary of provided information and verbal communication in discussions. Utilising sketches, models, charts and relevant symbols to explain characteristics of chain drives. Information hunt to obtain more information on chain drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mathematics: proportionality. Formula from first principles on gear drives Mechanics: force, torque and power. Sprocket strength and durability, metal alloy properties. Crystal structure of metals. Chain repairs - replacing damaged links.

MS2 - 8.3 GEAR TYPES, ARRANGEMENTS

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Unit Standard Outcomes:	Learners can describe the composition, features, dynamics, construction and maintenance of different gear drives. Learners can identify gear types, tooth types, and elaborate on their specific characteristics. Learners can explain the reasons for specific materials used for specific gear types. Learners can calculate ratios and write a report on different types of gear drive using grammatically correct language and spelling.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS. MS1-1.1 4.1 Metal Knowledge. Power, torque, force. Arithmetic, manipulation of formula. 8.5 Gear drives. Lubrication of gear types. Mechanics, mathematics, language.

Learner Activities: Learners examine a gear drive, discuss its construction, features, dynamics and maintenance. Do the calculations and find further sources of information about gear drives. Take notes of information provided, reflect verbally, write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while examining and discussing gear drives.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.3.1 ARRANGEMENT	8.3.2 FEATURES	8.3.4 DYNAMICS	8.3.5 MAINTENANCE
8.3.1.1 Spur, Helical, Double Helical Gears	8.3.2.1 Shaft Relative Positions	8.3.3.1 Teeth Contact Action - Rolling/Sliding	8.3.5.1 Lubrication
8.3.1.2 Straight, Spiral Bevel Gears	8.3.2.2 Gear Profiles	8.3.3.2 Gear Lubrication - Type	8.3.5.2 Backlash, Lubrication
8.3.1.3 Hypoid Gears	8.3.2.3 Teeth Profiles	8.3.4.3 Ratios	8.3.5.3 Gear Wear
8.3.1.4 Worm Drives	8.3.2.4 Materials	8.3.4.4 Alignment Features	8.3.5.4 Pit Marks, Causes
8.3.1.5 Epicyclical Gears (Ring, Sun, Planetary)	8.3.2.5 Axial Thrust	8.3.4.5 Even Ratios, Uneven Ratios (Timing)	8.3.5.5 Bearing Types, Adjustments
8.3.1.6 Rack and Pinion Gears	8.3.2.6 Operating Noise	8.3.4.6 Applications, Operating Speeds	8.3.5.6 Lubricant Contamination

KNOWLEDGE: OHS. Different types of gear drive. Driver and driven gears. Minimum helix angle for a wheel to drive a worm. Ratio and rotational speed calculations. Meshing actions of different gear types. Lubricant characteristics for different types of gear.

SKILLS: Safety procedures. Reading, writing summary of provided information and verbal communication in discussions. Utilising sketches, models, charts and relevant symbols to explain characteristics of gear drives. Information hunt to obtain more information on gear drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mechanics: force, torque and power. Mathematics: arithmetic, proportionality. Gear strength and durability, metal alloy properties. Crystal structure of metals. Teeth strength and gear size. Lubrication and pitting of teeth. Lubrication qualities, SAE, API and manufacturer grading. Chemistry of oil.

MS2 - 8.4 GEAR DRIVE TRAINS

Unit Standard Outcomes:
Learners can describe the composition, features and dynamics of gear drive trains.
Learners can calculate ratios, number of rotations from set timing to set timing.
Learners can report on the relationship between tooth strength, size and material.
Learners can write a report on gear drive trains using grammatically correct language and spelling.

Curriculum Outcomes:
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes:
Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-4.1 Metal Knowledge. Gear ratios. Arithmetic, manipulation of formula. MS1-8.5 Simple Gear Drives. Language.

Learner Activities: Learners examine a gear drive, discuss its arrangement, features and dynamics. Do the calculations and find further sources of information about gear drive trains. Take notes of information provided, reflect verbally, write a report on the information provided. Information hunt to obtain more information on gear drives.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while examining and discussing gear drives.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

8.4.1 ARRANGEMENT	8.4.3 FEATURES	8.4.4 DYNAMICS
8.4.1.1 Gears in a Single Strand Train (Single Set)	8.4.3.1 Common Tooth Type, Meshing	8.4.4.1 Pitch and Pitch Circle Diameter
8.4.1.2 Drivers, Driven and Idlers	8.4.3.2 Backlash	8.4.4.2 Effect of Idlers, Intermediate Gears on Driver-Driven Ratio
8.4.1.3 Single and Multiple Driven Shafts	8.4.3.3 Different Materials	8.4.4.3 Ratios and Rotational Frequencies
8.4.1.4 Gap Bridging – Idlers	8.4.3.4 Teeth Strength and Material	8.4.4.4 Timing - Shaft Timing
8.4.1.5	8.4.3.5 Teeth Strength and Gear Size	8.4.4.5 Even Ratios, Inter-Tooth Contact, Gear Timing Reason
		8.4.4.6 Multiple Timing Marks and Number of Rotations/Gear

KNOWLEDGE: OHS. Driver and driven gears. Ratio and rotational speed calculations - complex formula simplification. Calculate number of rotations for each gear to return to starting position - LCM.

SKILLS: Safety procedures. Reading, writing summary of provided information and verbal communication in discussions. Utilising sketches, models, charts and relevant symbols to explain characteristics of gear drives. Information hunt to obtain more information on gear drives. Do the calculations.

VALUES: Communication etiquette, respect. Personal and people safety. Value property, equipment and tools.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mechanics: force, torque and power. Mathematics: arithmetic, proportionality, LCM applications. Gear strength and durability, metal alloy properties. Crystal structure of metals. Teeth strength and gear size. Lubrication and pitting of teeth. Lubrication qualities, SAE, API and manufacturer grading. Chemistry of oil.

MECHANICAL SKILLS 3

MS3 - 1.1 PERSONAL QUALITIES

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Unit Standard Outcomes:	Learners can evaluate themselves and their peers against a set of criteria of entrepreneurial attributes. Learners can elaborate on the characteristics of entrepreneurs verbally and in writing using grammatically correct language. Learners can identify preferences from MS1 and MS2 units as possible business endeavours.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities (entrepreneurships).

Knowledge Foundation: MS1. MS2. Language: reading, writing, verbal communication. Arithmetic.

Learner Activities: Active participation: learners evaluate attributes and participate in small group and group discussions. Discuss individual preferences and estimate success.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating. Transdisciplinary integrated education.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

1.1.1 PREDISPOSITION	1.1.2 ORIENTATION	1.1.3 PERSONALITY TRAITS	1.1.4 SOCIAL ATTRIBUTES	1.1.5 PERSONAL VIRTUES
1.1.1.1 Confidence To Succeed	1.1.2.1 Competitive	1.1.3.1 Confidence	1.1.4.1 Passionate	1.1.5.1 Hard Working
1.1.1.2 Motivated	1.1.2.2 Refrain from Projection of Blame	1.1.3.2 Optimistic	1.1.4.2 Tolerant Towards Criticism and Rejection	1.1.5.2 Resourceful
1.1.1.3 Positive Approach	1.1.2.3 Desire for Responsibility	1.1.3.3 Energetic		1.1.5.3 Identifying Opportunities
1.1.1.4 Preference For Moderate Risk	1.1.2.4 Sensitive Towards Opportunities	1.1.3.4 Resolute Against Obstacles and Rejection	1.1.4.3 Openness To Change	1.1.5.4 Skill at Organising
1.1.1.5 Keep Up With Technology	1.1.2.5 Goal Focused		1.1.4.4 Extrovert	1.1.5.5 Desire for Achievement
1.1.1.6 Business Minded	1.1.2.6 Remain Committed: Dedication	1.1.3.5 Creative, Innovative and Resourceful	1.1.4.5 Good Interpersonal Relations	1.1.5.6 Desire for Immediate Feedback
1.1.1.7 Determination			1.1.4.6 Responsible	
			1.1.4.7 Disciplined	

KNOWLEDGE: OHS in terms of entrepreneurships - aspects applicable to entrepreneurships. Concept of micro-entrepreneurships and establishment of a low capital business class in local community. Entrepreneurial attributes and chances of success. Essential attributes.

SKILLS: Assessment of entrepreneurial attributes. Judgement on the possibility of developing attributes essential to entrepreneurship.

VALUES: Communication etiquette, respect and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcome and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Entrepreneurships, small businesses and market niches. Gaps in provision of goods, equipment or tools. Community needs/demands.

MS3 - 1.2 BUSINESS ENVIRONMENT

Unit Standard Outcomes:
Learners can explain the basics of the South African economy verbally and in writing using grammatically correct language.
Learners can explain business basics verbally and in writing using grammatically correct language.
Learners can explain the position and functions of micro entrepreneurships in a developing economy with high levels of unemployment.

Curriculum Outcomes:
Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes:
Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (entrepreneurships).

Knowledge Foundation: MS3-1.1 Personal Qualities. Low capital business class establishment. Language: reading, writing, verbal communication. Arithmetic.

Learner Activities: Active participation: learners collect information on economy, business and entrepreneurships. Learners elaborate on SA economic features, the place and sustainability of a micro-entrepreneurial business class and participate in small group and group discussions. Discuss micro entrepreneurships and chances of success. Discuss alternatives to entrepreneurships and their feasibility.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating. Transdisciplinary integrated education.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

1.2.1 SA and LOCAL ECONOMY	1.2.2 BUSINESS ENVIRONMENT	1.2.3 MBE* ENVIRONMENT	1.2.4 TARGET POPULATION	1.2.5 SUPPORT BASE
1.2.1.1 SA Economy - Structures	1.2.2.1 Principles of Business	1.2.3.1 Types of Entrepreneurships	1.2.4.1 Need(s)	1.2.5.1 Financial Support
1.2.1.2 Economic Principles	1.2.2.2 Functions	1.2.3.2 Justification and Functions	1.2.4.2 Financial Capacity	1.2.5.2 Provision of Raw Materials
1.2.1.3 Functioning of Economy	1.2.2.3 Targeted Population	1.2.3.3 Targeted Population	1.2.4.3 Approachability	1.2.5.3 Delivery of Material/Goods
1.2.1.4 Small Business Niche	1.2.2.4 Competition	1.2.3.4 Competition, Cooperation	1.2.4.4 Logistics	1.2.5.4 Employee(s)
1.2.1.5 Micro Business Niche	1.2.2.5 Sustainable Market Share	1.2.3.5 Sustainable Market Share	1.2.4.5 Sustainability	1.2.5.5 Micro Entrepreneurs
		*Micro Business Environment		

KNOWLEDGE: OHS in terms of entrepreneurships - aspects applicable to entrepreneurships. South African economy features and climate. Local economy and business features. Local micro entrepreneurship environment. Population demographics and target population(s). Support base for micro entrepreneurs.

SKILLS: Market "research". Assessment of local entrepreneurial environment. Establishing potential customer base.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Entrepreneurships, small businesses and market niches. Gaps in provision of goods, equipment or tools. Community needs/demands. Sustainability studies. Target population studies. Methods to determine gaps in provision of goods and services even in existing businesses - what they are not prepared to provide.

MS3 - 1.3 ENTREPRENEURIAL KNOWLEDGE AND SKILLS

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Unit Standard Outcomes: Learners can explain the basics of entrepreneurship verbally and in writing using grammatically correct language.
Learners can explain the business features of entrepreneurship verbally and in writing using grammatically correct language.
Learners can explain the management and finances of micro entrepreneurships in a developing economy with high levels of unemployment.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities (entrepreneurships).

Knowledge Foundation: MS3-1.2: basics of the South African economy; business basics; micro entrepreneurships. Language: reading, writing, verbal communication. Arithmetic.

Learner Activities: Active participation: learners collect information on economy, business and entrepreneurships. Learners elaborate on SA economic features, the place and sustainability of a micro-entrepreneurial business class and participate in small group and group discussions. Discuss micro entrepreneurships and chances of success. Discuss alternatives to entrepreneurships and their feasibility.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating. Transdisciplinary integrated education.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

1.3.1 BUSINESS BASICS	1.3.2 ENTREPRENEURSHIP	1.3.3 FINANCES, BOOKKEEPING	1.3.4 PROCUREMENT	1.3.5 PROFIT
1.3.1.1 Business Principles	1.3.2.1 Commodity/Service	1.3.3.1 Basics of Finances	1.3.4.1 Selection of Provider(s)	1.3.5.1 Cost Calculations
1.3.1.2 Justification - Population Needs	1.3.2.2 Venue, Preparation	1.3.3.2 Basics of Book Keeping	1.3.4.2 Business Arrangements	1.3.5.2 Product Value Determination
1.3.1.3 Target Population Size*	1.3.2.3 Low Capital Layout	1.3.3.3 Profit, Capital, Expenses and Personal Income Ratios	1.3.4.3 Payment Arrangements	1.3.5.3 Price Comparisons
1.3.1.4 Population Awareness (Advertise)	1.3.2.4 High Personal Involvement		1.3.4.4 Delivery Arrangement	1.3.5.4
1.3.1.5 Market Share	1.3.2.5 Management, Quality	1.3.3.4 Business Expansion	1.3.4.5 Quality Control	
*Visits or Service/Product Enquiries	1.3.2.6 Laws and Regulations + Local			

KNOWLEDGE: OHS in terms of entrepreneurships - aspects applicable to entrepreneurships. Business basics and principles. Micro entrepreneurship features and running a micro entrepreneurship.

SKILLS: Methods and techniques to acquire information from authorities, target population, suppliers and institutions.

VALUES: Communication etiquette, respect and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Entrepreneurships, small businesses and market niches. Gaps in provision of goods, equipment or tools. Community needs/demands. Sustainability studies. Target population studies. Methods to determine gaps in provision of goods and services even in existing businesses - what they are not prepared to provide.

MS3 - 1.4 MANAGEMENT

Unit Standard Outcomes:	Learners can explain entrepreneurship business plan and setup verbally and in writing using grammatically correct language. Learners can explain entrepreneurship running verbally and in writing using grammatically correct language. Learners can explain entrepreneurship interactions verbally and in writing using grammatically correct language.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities (entrepreneurships).

Knowledge Foundation: MS3-1.3: South African economic, business basics and micro entrepreneurship environments. Language: reading, writing, verbal communication. Bookkeeping.

Learner Activities: Active participation: learners collect information on economy, business and entrepreneurships. Learners elaborate on SA economic features, the place and sustainability of a micro-entrepreneurial business class and participate in small group and group discussions. Discuss micro entrepreneurships and chances of success. Discuss alternatives to entrepreneurships and their feasibility.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating. Transdisciplinary integrated education.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

1.4.1 BUSINESS PLAN	1.4.2 BUSINESS SETUP	1.4.3 PRODUCTION PROCEDURE	1.4.4 QUALITY ASSURANCE	1.4.5 CUSTOMER FEEDBACK	1.4.6 INTERACTION - PEERS
1.4.1.1 Business Description	1.4.2.1 Implementation Plan	1.4.3.1 Venue Preparation	1.4.4.1 Quality Criteria	1.4.5.1 Methods to Receive	1.4.6.1 Peer Communication
1.4.1.2 Product/Service	1.4.2.2 Business Systems	1.4.3.2 Equipment, Tools Needed	1.4.4.2 Raw Material Quality	1.4.5.2 Customer Satisfaction	1.4.6.2 Mutual Support
1.4.1.3 Market Analysis	1.4.2.3 Register as Self-employed	1.4.3.3 Product/Service Plans	1.4.4.3 Meticulous Testing	1.4.5.3 Customer Proposals	1.4.6.3 Peer Evaluation
1.4.1.4 Business Strategy	1.4.2.4 Register for VAT	1.4.3.4 Production/Service Procedure	1.4.4.4 Improvement Plans	1.4.5.4 Review Proposals	1.4.6.4 Quality Assessment
1.4.1.5 Team, Employment	1.4.2.5 Get Bank Account	1.4.3.5 Quality Control		1.4.5.5 Implement Feasible Ones	
1.4.1.6 Financial Planning	1.4.2.6 Get Local Permission				

KNOWLEDGE: OHS in terms of entrepreneurships. Laws, regulations, entrepreneurships and registration procedures. Set up and running a micro entrepreneurship.

SKILLS: Plan, set up and running a micro entrepreneurship. Business arrangements with bank, suppliers and peers.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Principles of small businesses and entrepreneurships. Methods and techniques to improve and expand business. Acquisition of capital to finance growth. Methods and techniques to do market surveys to support improvement, expansion or addition of new fields.

MS3 - 1.5 MICRO MARKETING

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Unit Standard Outcomes:	Learners can explain market survey verbally and in writing using grammatically correct language. Learners can explain community needs and customer care verbally and in writing using grammatically correct language. Learners can explain advertising and sales verbally and in writing using grammatically correct language.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities (entrepreneurships).

Knowledge Foundation: MS3-1.4: Setting up and running a micro entrepreneurship. Bookkeeping. Language: reading, writing, verbal communication.

Learner Activities: Active participation: learners collect information in a community, identifying needs, potential and sustainability. Collect information on customer handling, after sales care and marketing strategies.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating. Transdisciplinary integrated education.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

1.5.1 MARKET SURVEY	1.5.2 COMMUNITY NEEDS	1.5.3 CUSTOMERS CARE	1.5.5 ADVERTISEMENT	1.5.6 DOOR-TO-DOOR
1.5.1.1 Identify Potential Customers	1.5.2.1 Needs within Skills Field	1.5.3.1 Customer Satisfaction	1.5.5.1 Satisfied Customers	1.5.6.1 Only Target Population
1.5.1.2 Gaps in Provision, Goods/Services	1.5.2.2 Service/Goods Preference	1.5.3.2 After Sales Service/Contact	1.5.5.2 Newspapers	1.5.6.2 Timing is Important
1.5.1.3 Potential of Identified Need	1.5.2.3 Create Awareness of Need(s) Product Makes Life Easier	1.5.3.3 Immediate Response to Queries	1.5.5.3 Posters	1.5.6.3 Person for Consultation
1.5.1.4 Sustainability of Demand: Determine Saturation Point		1.5.3.4 Dealing with Problems	1.5.5.4 Radio	1.5.6.4 Brief, to the Point, Significant
	1.5.2.4			
1.5.1.5 Sustainability of Provision				

KNOWLEDGE: OHS in terms of entrepreneurships. Execution of marketing surveys. Marketing strategies. Business communication, sales and customer care.

SKILLS: Executing a survey. Selling goods or services. Communication and interpersonal relationships.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Survey planning and execution. Drafting stimulating, encouraging and effective advertisements. Marketing strategies and techniques.

MS3 - 1.6 OPPORTUNITY HUNTING

Unit Standard Outcomes:	Learners can explain market survey verbally and in writing using grammatically correct language. Learners can explain community needs and customer care verbally and in writing using grammatically correct language. Learners can explain advertising and sales verbally and in writing using grammatically correct language.
Curriculum Outcomes:	Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities (entrepreneurships).

Knowledge Foundation: MS3-1.4: Setting up and running a micro entrepreneurship. Bookkeeping. Language: reading, writing, verbal communication.

Learner Activities: Active participation: learners collect information in a community, identifying needs, potential and sustainability. Collect information on customer handling, after sales care and marketing strategies.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating. Transdisciplinary integrated education.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

1.6.1 ENTREPRENEURIAL OPPORTUNITIES	1.6.2 MARKET GAPS	1.6.3 COMMUNITY NEEDS	1.6.4 BUSINESS NEEDS
1.6.1.1 Business Gaps in Service Provision	1.6.2.1 Services Businesses find Inconvenient to Provide	1.6.3.1 Community Need for Services*	1.6.4.1 Service Provision to Businesses
1.6.1.2 Business Gaps in goods Provision		1.6.3.2 Community Need for Goods (Sales)*	1.6.4.2 Service Provision to Industry
1.6.1.3 Opportunities in Manufacturing Goods	1.6.2.2 Goods Businesses find Inconvenient to Handle	1.6.3.3 Community Need for Equipment*	
1.6.1.4 Manufacturing Essential Equipment		1.6.3.4 Community Need for Ornaments*	
1.6.1.5 Manufacturing Nice-to-Have Articles	1.6.2.3 Business Equipment Not Readily Available	1.6.3.5 Community Need for Garden Furniture*	
	1.6.2.4 Article for Sale in Existing Businesses	* Survey	

KNOWLEDGE: OHS in terms of entrepreneurships. Execution of marketing surveys. Marketing strategies. Business communication, sales and customer care.

SKILLS: Executing a survey. Selling goods or services. Communication and interpersonal relationships.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Survey planning and execution. Drafting stimulating, encouraging and effective advertisements. Marketing strategies and techniques.

MS3 - 2.1 BURGLAR PROOFING

February 2011

Unit Standard Outcomes:	Learners can plan projects, compile a construction plan, make sketches, drawings and execution procedure according to OHS. Learners can do all the calculations involved accurately. Learners can motivate their project choices; explain operations, verbally and in writing using grammatically correct language and spelling; show calculations.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Organise and manage themselves and their activities responsibly and effectively. Identify and solve problems and make decisions using critical and creative thinking. Explore education and career opportunities.

Knowledge Foundation: OHS. MS1-5. Language: speak, read and write. Science,Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metal work.

Learner Activities: Active participation: negotiate a deal. Execute the calculations and manual labour. Reflect verbally. Write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

2.1.1 PROJECT PLANNING	2.1.2 QUOTATION	2.1.3 PROJECT CONSTRUCTION	2.1.4 ASSEMBLING/MOUNTING	2.1.5 INVOICING, COLLECTION
2.1.1.1 Planning, Arrangement (Owner)	2.1.2.1 Material Quotations (Provider)	2.1.3.1 Site Preparation	2.1.4.1 Delivery to Assembly Site (Opt)	2.1.5.1 Deliver invoice according to prior agreement.
2.1.1.2 Structure Plan and Sketch	2.1.2.2 Accessories Quotations (Provider)	2.1.3.2 Construction Procedure	2.1.4.2 Layout of Units	
2.1.1.3 Measurements	2.1.2.3 Material Cost Calculations	2.1.3.3 Identify Material for Parts	2.1.4.3 Apply Assembly Plan	2.1.5.2 Collect payment according to prior agreement.
2.1.1.4 Project Plan(s) Drawings	2.1.2.4 Time Schedule and Labour Costs	2.1.3.4 Making Project Parts	2.1.4.4 Check Operation, Functionality	
2.1.1.5 Material Selection (Customer)	2.1.2.5 Material Delivery Cost	2.1.3.5 Project Layout: Construction Plan	2.1.4.5 Finishing, Polishing	
2.1.1.6 Material Calculations	2.1.2.6 Production Costs	2.1.3.6 Joining the parts/Welding	2.1.4.6 Corrosion Protection: Touching up Paint Damage, Refining	
2.1.1.7 Construction Plan	2.1.2.7 Profit, Price Calculation	2.1.3.7 Shaping, Refining, Polishing		
Confirm construction and mounting plan and payment agreement with customer	2.1.2.8 Total Price, Detailed	2.1.3.8 Corrosion Protection		

KNOWLEDGE: OHS. Electricity, metal cutting, shaping, finishing, welding and corrosion protection. Plan and design a project, obtain material and develop a construction plan. Negotiate a deal with a customer.

SKILLS: Operate equipment safely and correctly according to procedure. Execute welding procedures and techniques resulting in strong joints. Systematically construct the components and assemble them into a useful object. Spray painting.

VALUES: Communication etiquette, respect for and empathy with customers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Welding equipment, tools, material and protective gear. Material characteristics, shielding gasses, flux, filler material. Joint preparation, welding methods and techniques. Improved methods of welding. Alternative cutting and welding machines. Gas welding plants, procedures, precautions and flame types appropriate for different processes.

MS3 - 2.2 GARDEN FURNITURE

Unit Standard Outcomes:	Learners can plan projects, compile a construction plan, make sketches, drawings and execution procedure according to OHS. Learners can do all the calculations involved accurately. Learners can motivate their project choices; explain operations, verbally and in writing using grammatically correct language and spelling; show calculations.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Organise and manage themselves and their activities responsibly and effectively. Identify and solve problems and make decisions using critical and creative thinking. Explore education and career opportunities.

Knowledge Foundation: OHS. MS1-5. Language: speak, read and write. Science,Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metal work.

Learner Activities: Active participation: negotiate a deal. Execute the calculations and manual labour. Reflect verbally. Write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

2.2.1 MARKET SURVEY - DEMAND	2.2.2 PROJECT PLANNING	2.2.3 COST, PRICE CALCULATIONS	2.2.4 PROJECT CONSTRUCTION	2.2.5 MARKETING
2.2.1.1 Survey Plan - Type, Method	2.2.2.1 Planning	2.2.3.1 Material Quotations (Provider)	2.2.4.1 Site Preparation	2.2.5.1 Flea Markets
2.2.1.2 Target Population	2.2.2.2 Structure Plan and Sketch	2.2.3.2 Accessories Quotations (Provider)	2.2.4.2 Construction Procedure	2.2.5.2 Door-to-Door
2.2.1.3 Survey Execution	2.2.2.3 Measurements	2.2.3.3 Material Cost Calculations	2.2.4.3 Identify Material for Parts	2.2.5.3 Advertisements
2.2.1.4 Survey Analysis, Conclusion	2.2.2.4 Project Plan(s) Drawings	2.2.3.4 Time Schedule and Labour Costs	2.2.4.4 Making Project Parts	2.2.5.4 Business Associates
2.2.1.5 Change Target Population (Alt)	2.2.2.5 Material Selection (Customer)	2.2.3.5 Material Delivery Cost	2.2.4.5 Project Layout: Construction Plan	
2.2.1.6 Repeat Survey	2.2.2.6 Material Calculations	2.2.3.6 Production Costs	2.2.4.6 Joining the parts/Welding	
	2.2.2.7 Construction Plan	2.2.3.7 Profit, Price Calculation	2.2.4.7 Shaping, Refining, Polishing	
	2.2.2.8 Worksite Selection	2.2.3.8 Selling Price	2.2.4.8 Corrosion Protection	
		2.2.3.9 Compare Prices	2.2.4.9 Number in Stock?	

KNOWLEDGE: OHS. Electricity, metal cutting, shaping, finishing, welding and corrosion protection. Plan and design a project, obtain material and develop a construction plan. Negotiate a deal with a customer.

SKILLS: Operate equipment safely and correctly according to procedure. Execute welding procedures and techniques resulting in strong joints. Systematically construct the components and assemble them into a useful object. Spray paint object.

VALUES: Communication etiquette, respect for and empathy with customers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Welding equipment, tools, material and protective gear. Material characteristics, shielding gasses, flux, filler material. Joint preparation, welding methods and techniques. Improved methods of welding. Alternative cutting and welding machines. Gas welding plants, procedures, precautions and flame types appropriate for different processes.

MS3 - 2.3 BARBECUE AND EQUIPMENT

February 2011

Unit Standard Outcomes:	Learners can plan projects, compile a construction plan, make sketches, drawings and execution procedure according to OHS. Learners can do all the calculations involved accurately. Learners can motivate their project choices; explain operations, verbally and in writing using grammatically correct language and spelling; show calculations.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Organise and manage themselves and their activities responsibly and effectively. Identify and solve problems and make decisions using critical and creative thinking. Explore education and career opportunities.

Knowledge Foundation: OHS. MS1-5. Language: speak, read and write. Science,Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metal work.

Learner Activities: Active participation: negotiate a deal. Execute the calculations and manual labour. Reflect verbally. Write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

2.3.1 MARKET SURVEY - DEMAND	2.3.2 PROJECT PLANNING	2.3.3 COST, PRICE CALCULATIONS	2.3.4 PROJECT CONSTRUCTION	2.3.5 MARKETING
2.3.1.1 Survey Plan - Type, Method	2.3.2.1 Planning	2.3.3.1 Material Quotations (Provider)	2.3.4.1 Site Preparation	2.3.5.1 Flea Markets
2.3.1.2 Target Population	2.3.2.2 Structure Plan and Sketch	2.3.3.2 Accessories Quotations (Provider)	2.3.4.2 Construction Procedure	2.3.5.2 Door-to-Door
2.3.1.3 Survey Execution	2.3.2.3 Measurements	2.3.3.3 Material Cost Calculations	2.3.4.3 Identify Material for Parts	2.3.5.3 Advertisements
2.3.1.4 Survey Analysis, Conclusion	2.3.2.4 Project Plan(s) Drawings	2.3.3.4 Time Schedule and Labour Costs	2.3.4.4 Making Project Parts	2.3.5.4 Business Associates
2.3.1.5 Change Target Population (Alt)	2.3.2.5 Material Selection (Customer)	2.3.3.5 Material Delivery Cost	2.3.4.5 Project Layout: Construction Plan	2.3.5.5 Combination of Methods
2.3.1.6 Repeat Survey	2.3.2.6 Material Calculations	2.3.3.6 Production Costs	2.3.4.6 Joining the parts/Welding	
	2.3.2.7 Construction Plan	2.3.3.7 Profit, Price Calculation	2.3.4.7 Shaping, Refining, Polishing	
	2.3.2.8 Worksite Selection	2.3.3.8 Selling Price	2.3.4.8 Corrosion Protection	
		2.3.3.9 Compare Prices	2.3.4.9 Numbers in Stock?	

KNOWLEDGE: OHS. Electricity, metal cutting, shaping, finishing, welding and corrosion protection. Plan and design a project, obtain material and develop a construction plan. Negotiate a deal with a customer.

SKILLS: Operate equipment safely and correctly according to procedure. Execute welding procedures and techniques resulting in strong joints. Systematically construct the components and assemble them into a useful object. Spray paint object.

VALUES: Communication etiquette, respect and empathy with customers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Welding equipment, tools, material and protective gear. Material characteristics, shielding gasses, flux, filler material. Joint preparation, welding methods and techniques. Improved methods of welding. Alternative cutting and welding machines. Gas welding plants, procedures, precautions and flame types appropriate for different processes.

Unit Standard Outcomes:	Learners can plan projects, compile a construction plan, make sketches, drawings and execution procedure according to OHS. Learners can do all the calculations involved accurately. Learners can motivate their project choices; explain operations, verbally and in writing using grammatically correct language and spelling; show calculations.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension. Demonstrate ability to plan and execute assignments effectively complying to OHS regulations, safe handling of tools and equipment and prescribed procedure.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Organise and manage themselves and their activities responsibly and effectively. Identify and solve problems and make decisions using critical and creative thinking. Explore education and career opportunities.

Knowledge Foundation: OHS. MS1-5. Language: speak, read and write. Science,Technology, Mechanics and Mathematics, metal knowledge, welding, drilling, metal work.

Learner Activities: Active participation: Negotiate a deal. Execute the calculations and manual labour. Reflect verbally. Write a report on the information and proceedings.

Presentation policy: Learners learn by doing - learners acquire knowledge (declarative), skills and values (procedural knowledge) while working with their hands.

Theoretical Foundation: Constructivist education. Relevance, relationships, significance and declarative and procedural knowledge integration and extension.

2.4.1 MARKET SURVEY - DEMAND	2.4.2 PROJECT PLANNING	2.4.3 COST, PRICE CALCULATIONS	2.4.4 PROJECT CONSTRUCTION	2.4.5 MARKETING
2.4.1.1 Survey Plan - Type, Method	2.4.2.1 Planning	2.4.3.1 Material Quotations (Provider)	2.4.4.1 Site Preparation	2.4.5.1 Flea Markets
2.4.1.2 Include Range of Appliances	2.4.2.2 Structure Plan and Sketch	2.4.3.2 Accessories Quotations (Provider)	2.4.4.2 Construction Procedure	2.4.5.2 Door-to-Door
2.4.1.3 Target Population	2.4.2.3 Measurements	2.4.3.3 Material Cost Calculations	2.4.4.3 Identify Material for Parts	2.4.5.3 Advertisements
2.4.1.4 Survey Execution	2.4.2.4 Project Plan(s) Drawings	2.4.3.4 Time Schedule and Labour Costs	2.4.4.4 Making Project Parts	2.4.5.4 Business Associates
2.4.1.5 Survey Analysis, Conclusion	2.4.2.5 Material Selection (Customer)	2.4.3.5 Material Delivery Cost	2.4.4.5 Project Layout: Construction Plan	2.4.5.5 Combination of Methods
2.4.1.6 Change Target Population (Alt)	2.4.2.6 Material Calculations	2.4.3.6 Production Costs	2.4.4.6 Joining the parts/Welding	
2.4.1.7 Repeat Survey	2.4.2.7 Construction Plan	2.4.3.7 Profit, Price Calculation	2.4.4.7 Shaping, Refining, Polishing	
	2.4.2.8 Worksite Selection	2.4.3.8 Selling Price	2.4.4.8 Corrosion Protection	
		2.4.3.9 Compare Prices	2.4.4.9 Numbers in Stock???	

KNOWLEDGE: OHS. Electricity, metal cutting, shaping, finishing, welding and corrosion protection. Plan and design a project, obtain material and develop a construction plan. Negotiate a deal with a customer.

SKILLS: Operate equipment safely and correctly according to procedure. Execute welding procedures and techniques resulting in strong joints. Systematically construct the components and assemble them into a useful object. Spray painting.

VALUES: Communication etiquette, respect for and empathy with customers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Welding equipment, tools, material and protective gear. Material characteristics, shielding gasses, flux, filler material. Joint preparation, welding methods and techniques. Improved methods of welding. Alternative cutting and welding machines. Gas welding plants, procedures, precautions and flame types appropriate for different processes.

MS3 - 3.1 REPLACE SHOCK ABSORBERS

February 2011

Unit Standard Outcomes: Learners can locate and identify shock absorbers, mountings, locking devices, describe functions in relation to vehicle operation.
Learners can remove shock absorbers, using the right tools and equipment according to procedure and OHS.
Learners can demonstrate and explain the operation of shock absorbers and write a report on their experiences using grammatically correct language and spelling.
Learners can do the basic calculations and explain the physics to demonstrate comprehension and appreciation of the functioning of shock absorbers.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS, Vehicle Care, MS1-1.2 Hand Tools, MS1-2 Vehicle Lifting. MS1-6. 2. Language, mathematics, mechanics, basic physics - energy, forces.

Learner Activities: Learners put a vehicle on a hoist or trestles, replace shock absorber according to OHS and workshop procedures. Take notes of information provided, reflect verbally, write a report on the information provided. Market survey. Negotiate with a customer.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

3.1.1 MARKET SURVEY - DEMAND	3.1.2 COST, PRICE CALCULATIONS	3.1.3 QUOTATION	3.1.4 REPLACE SHOCK ABSORBERS	3.1.5 MARKETING
3.1.1.1 Survey Plan - Type, Method	3.1.2.1 Parts Quotations (Provider)	3.1.3.1 Parts Quotations (Provider)	3.1.4.1 Remove Shock Absorber	3.1.5.1 Method of Marketing
3.1.1.2 Target Population	3.1.2.2 Accessories Quotations (Provider)	3.1.3.2 Accessories Quotations (Provider)	3.1.4.2 Check for Damage	
3.1.1.3 Survey Execution	3.1.2.3 Parts Cost Calculations	3.1.3.3 Parts Cost Calculations	3.1.4.3 Test Operation	3.1.6 INVOICING, COLLECTION
3.1.1.4 Survey Analysis, Conclusion	3.1.2.4 Time Schedule	3.1.3.4 Time Schedule, Labour Costs	3.1.4.4 Adjust Shock (Optional)	3.1.6.1 Deliver invoice according to
3.1.1.5 Change Target Population (Alt)	3.1.2.5 Labour Cost	3.1.3.5 Parts Delivery Cost	3.1.4.5 Mount shock, Secure	prior agreement.
3.1.1.6 Repeat Survey	3.1.2.6 Profit, Price Calculation	3.1.3.6 Overheads	3.1.4.6 Check Operation	3.1.6.2 Collect payment according to
Confirm instruction and payment	3.1.2.7 Service Price	3.1.3.7 Profit, Price Calculation	3.1.4.7 Prepare Vehicle for Delivery	prior agreement.
agreement with customer	3.1.2.8 Compare Prices	3.1.3.8 Total Price, Detailed		

KNOWLEDGE: OHS. Shock absorber operation. Reservoir pressure and increase of pressure from external source. Forces on shock absorber, angle of shock in relation to wheel movement and effects. Function of and effects of shocks too hard or too soft - relation to vehicle mass. Work report and relevant documentation. Language, physics, mechanics, basic math. Basics of business, customer relations. Market survey, quotations, customer care.

SKILLS: Safety procedures. Lifting and securing vehicle. Operating the vehicle hoist. Replace shock absorbers, check and test. Vehicle care. Remove vehicle from jack, stands.

VALUES: Communication etiquette, respect for and empathy with client, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Entrepreneurial skills. Customer confidence. Communication skills. Verbal, written reports to customer.

MS3 - 3.2 REPLACE EXHAUST SYSTEMS

Unit Standard Outcomes: Learners can identify exhaust system, mountings, mounting devices and describe functions in relation to vehicle operation.
Learners can remove exhaust systems, using the tools correctly and equipment according to procedure and OHS.
Learners can explain the operation of exhaust systems and write a report on their experiences using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate ability to communicate effectively through oral and written presentations, supported by reading and comprehension.
Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.

Knowledge Foundation: MS1-1.1 OHS, Vehicle care, MS1-1.2 Hand Tools, MS1-2 Vehicle Lifting. Language, basic mathematics, mechanics.

Learner Activities: Learners put a vehicle on a hoist or stands and replace exhaust system, or piece of, according to OHS and workshop procedures. Take notes of information provided, reflect verbally, write a report on the information provided. Negotiate with a customer.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

3.2.1 MARKET SURVEY - DEMAND	3.2.2 COST, PRICE CALCULATIONS	3.2.3 QUOTATION	3.2.4 REPLACE EXHAUST SYSTEMS	3.2.5 MARKETING
3.2.1.1 Survey Plan - Type, Method	3.2.2.1 Parts Quotations (Provider)	3.2.3.1 Parts Quotations (Provider)	3.2.4.1 Put Vehicle on Hoist/Stands	3.2.5.1 Method of Marketing
3.2.1.2 Target Population	3.2.2.2 Accessories Quotations (Provider)	3.2.3.2 Accessories Quotations (Provider)	3.2.4.2 Remove Exhaust system	
3.2.1.3 Survey Execution	3.2.2.3 Parts Cost Calculations	3.2.3.3 Parts Cost Calculations	3.2.4.3 Check for Damage	3.2.6 INVOICING, COLLECTION
3.2.1.4 Survey Analysis, Conclusion	3.2.2.4 Time Schedule	3.2.3.4 Time Schedule, Labour Costs	3.2.4.4 Mount exhaust, Secure	3.2.6.1 Deliver invoice according to prior agreement.
3.2.1.5 Change Target Population (Alt)	3.2.2.5 Labour Cost	3.2.3.5 Parts Delivery Cost	3.2.4.5 Check Operation, Leaks	
3.2.1.6 Repeat Survey	3.2.2.6 Profit, Price Calculation	3.2.3.6 Overheads	3.2.4.6 Prepare Vehicle for Delivery	3.2.6.2 Collect payment according to prior agreement.
Confirm instruction and payment agreement with customer	3.2.2.7 Service Price	3.2.3.7 Profit, Price Calculation		
	3.2.2.8 Compare Prices	3.2.3.8 Total Price, Detailed		

KNOWLEDGE: OHS. Exhaust system operation. Silencer construction and operation. Reduced flow and "back pressure" on engine economy and performance. Noise levels and sound pollution. Work report and relevant documentation. Language, physics, mechanics, basic math. Basics of business, customer relations.

SKILLS: Safety procedures. Lifting and securing vehicle. (Operating the vehicle hoist.) Replace exhaust systems, check and test. Vehicle care. Remove vehicle from hoist, stands.

VALUES: Communication etiquette, respect for and empathy with client, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Entrepreneurial skills. Customer confidence. Communication skills. Verbal, written reports to customer. Vehicle noise tolerances - Road Ordinance.

MS3 - 3.3 LUBRICATION SERVICE

February 2011

Unit Standard Outcomes: Learners can locate and identify engine filters, describe functions in relation to engine operation and motivate the needs of lubrication services.
Learners can replace filters, engine oil, and dispose of filters and oil in the prescribed manner.
Learners can do the inspections and write a report according to the procedure.
Learners demonstrate appreciation of property, tidiness, and interpersonal relationships.

Curriculum Outcomes: Demonstrate ability to learn and employ techniques to improve learning capacity.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Learners demonstrate appreciation of property, tidiness and interpersonal interaction.

Critical Outcomes: Communicate effectively using visual, symbolic and/or language skills in various modes.
Collect, analyse, organise and critically evaluate information.
Explore education and career opportunities.

Knowledge Foundation: Lubrication Principles and Temperature Control. Viscosity and Temperature. Lubricant Classification, Coolant Additive Function, Classification, Motivation for Frequent Services, OHS. Vehicle Care, Handling of Tools and Equipment. Service procedures, inspection procedures.

Learner Activities: Learners do a feasibility survey, come to a conclusion and write a report. Learners put a vehicle on a hoist or stands and perform a lubrication service according to OHS and workshop procedures. Replace oil, fuel and air filters. Drain lubricant and refill with specified oil. Negotiate with a customer. Take notes of information provided, reflect verbally and write a report on the information provided.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

3.2.1 MARKET SURVEY - DEMAND	3.2.2 COST, PRICE CALCULATIONS	3.2.3 QUOTATION	3.2.4 LUBRICATION SERVICE	3.2.5 MARKETING
3.2.1.1 Survey Plan - Type, Method	3.2.2.1 Parts, Oil Quotations (Provider)	3.2.3.1 Parts Oil Quotations (Provider)	3.2.4.1 Put Vehicle on Hoist/Stands	3.2.5.1 Method of Marketing
3.2.1.2 Target Population	3.2.2.2 Accessories Quotations (Provider)	3.2.3.2 Accessories Quotations (Provider)	3.2.4.2 Drain Lubricant	
3.2.1.3 Survey Execution	3.2.2.3 Parts, Oil Cost Calculations	3.2.3.3 Parts, Oil Cost Calculations	3.2.4.3 Replace Oil, Fuel Filters	3.2.6 INVOICING, COLLECTION
3.2.1.4 Survey Analysis, Conclusion	3.2.2.4 Time Schedule	3.2.3.4 Time Schedule, Labour Costs	3.2.4.4 Clean Air Cleaner Bowl and Replace Air Filter	3.2.6.1 Deliver invoice according to prior agreement.
3.2.1.5 Change Target Population (Alt)	3.2.2.5 Labour Cost	3.2.3.5 Parts Delivery Cost		
3.2.1.6 Repeat Survey	3.2.2.6 Profit, Price Calculation	3.2.3.6 Overheads	3.2.4.5 Check Operation, Leaks	3.2.6.2 Collect payment according to prior agreement.
Confirm instruction and payment	3.2.2.7 Service Price	3.2.3.7 Profit, Price Calculation	3.2.4.6 Do Routine Checks	
agreement with customer	3.2.2.8 Compare Prices	3.2.3.8 Total Price, Detailed	3.2.4.7 Prepare Vehicle for Delivery	

KNOWLEDGE: OHS. Lubrication Principles and Temperature Control. Viscosity and Temperature. Lubricant Classification, Coolant Additive Function, Classification. Lubrication service procedure. Motivation for Frequent Services.

SKILLS: Safety. Lifting and securing vehicle. (Operating the vehicle hoist.) Perform lubrication service, check and test. Vehicle care. Remove vehicle from hoist, stands.

VALUES: Communication etiquette, respect for and empathy with client, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Entrepreneurial skills. Customer confidence. Communication skills. Verbal, written reports to customer. Lubricant classification and quality. Viscosity index.

Unit Standard Outcomes:	Learners can safely replace a motor vehicle battery. Learners can neutralise spilled acid and clean the hold-down, battery tray and surrounding area. Learners can service a motor vehicle battery. Learners can do the inspections and write a report according to the procedure.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications. Learners demonstrate appreciation of property, tidiness and interpersonal interaction.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities.
Knowledge Foundation:	OHS. Composition of motor vehicle battery electrolytes and the dangers of incorrect handling. Battery replacement procedure. Battery charging.
Learner Activities:	Learners neutralise battery acid, remove lead sulphate and ferry-sulphate from the battery and surroundings. Remove and service a battery. Charge a battery. Replace the battery. Market survey, quotations, customer care.
Presentation policy:	Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.
Theoretical Foundation:	Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

3.4.1 MARKET SURVEY - DEMAND	3.4.2 COST, PRICE CALCULATIONS	3.4.3 QUOTATION	3.4.4 BATTERY SERVICE	3.4.5 MARKETING
3.4.1.1 Survey Plan - Type, Method	3.4.2.1 Battery, Electrolyte Quotations	3.4.3.1 Battery, Electrolyte Quotations	3.4.4.1 Remove, Clean Battery	3.4.5.1 Method of Marketing
3.4.1.2 Target Population	3.4.2.2 Accessories Quotations (Provider)	3.4.3.2 Accessories Quotations (Provider)	3.4.4.2 External, Internal Inspection	
3.4.1.3 Survey Execution	3.4.2.3 Cost Calculations	3.4.3.3 Cost Calculations	3.4.4.3 Check State of Charge	3.4.6 INVOICING, COLLECTION
3.4.1.4 Survey Analysis, Conclusion	3.4.2.4 Time Schedule	3.4.3.4 Time Schedule, Labour Costs	3.4.4.4 Recharge Battery	3.4.6.1 Deliver invoice according to prior agreement.
3.4.1.5 Change Target Population (Alt)	3.4.2.5 Labour Cost	3.4.3.5 Battery Delivery Cost	3.4.4.5 Recheck Electrolyte Level	
3.4.1.6 Repeat Survey	3.4.2.6 Profit, Price Calculation	3.4.3.6 Overheads	3.4.4.6 Neutralise Acid, Clean, Dry	3.4.6.2 Collect payment according to prior agreement.
Confirm instruction and payment agreement with customer	3.4.2.7 Service Price	3.4.3.7 Profit, Price Calculation	3.4.4.7 Replace Battery	
	3.4.2.8 Compare Prices	3.4.3.8 Total Price, Detailed	3.4.4.8 Prepare Vehicle for Delivery	

KNOWLEDGE:	OHS. Composition of the chemicals of a battery. The dangers of these chemicals. The basic chemical reactions when charging and discharging a battery. The gasses released during these processes. Battery care. Battery life span - full cycles. Dangers of long periods in a discharged state. Motivation for frequent services.
SKILLS:	Safety. Neutralising acid, cleaning a battery, battery hold down, box and surroundings. Replace a battery. Recharge a battery. Take RD readings and estimate state of charge.
VALUES:	Communication etiquette, respect and empathy with client, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.
ASSESSMENT CRITERIA:	Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate. Continuous observation and recording of learner participation and performance. Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks. Summative assessment to verify accomplishment of outcomes. Verify comprehension, competence and knowledge retention. Determine significance of the learning content to the learners. Determine learner perspective - relevance and relationships within curriculum context.
LINKS:	Entrepreneurial skills. Customer confidence. Communication skills. Verbal, written reports to customer. External and internal current flow. External and internal resistances. Elaboration on the chemical processes and how current flow takes place - electron, ion flow.

MS3 - 3.5 ENGINE REPLACEMENT

February 2011

Unit Standard Outcomes:	Learners can read the procedure from workshop manual, follow the study guide and safely replace a motor vehicle engine. Learners can do the inspections, write a report and complete a job card according to the procedure. Learners can explain why the angles formed by the sling should not be too small, verbally and in writing using grammatically correct language.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications. Learners demonstrate appreciation of property, tidiness and interpersonal interaction.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities.

Knowledge Foundation: OHS. Tools and equipment. Forces in different parts of the sling. The effect of angle size on the forces. Language, mechanics, mathematics.

Learner Activities: Learners prepare a quotation for the customer. Replace engine support components and the engine. Prepare the engine for starting. Prepare the vehicle.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing vehicle layout.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

3.4.1 MARKET SURVEY - DEMAND	3.4.2 COST, PRICE CALCULATIONS	3.4.3 QUOTATION	3.4.4 ENGINE REPLACEMENT	3.4.5 MARKETING
3.4.1.1 Survey Plan - Type, Method	3.4.2.1 Parts Quotations (Provider)	3.4.3.1 Parts Quotations (Provider)	3.4.4.1 Remove Engine	3.4.5.1 Method of Marketing
3.4.1.2 Target Population	3.4.2.2 Accessories Quotations (Provider)	3.4.3.2 Accessories Quotations (Provider)	3.4.4.2 Clean Engine, Vehicle	
3.4.1.3 Survey Execution	3.4.2.3 Cost Calculations	3.4.3.3 Cost Calculations	3.4.4.3 Inspection, Preparation	3.4.6 INVOICING, COLLECTION
3.4.1.4 Survey Analysis, Conclusion	3.4.2.4 Time Schedule	3.4.3.4 Time Schedule, Labour Costs	3.4.4.4 Mount (replacement) Engine	3.4.6.1 Deliver invoice according to prior agreement.
3.4.1.5 Change Target Population (Alt)	3.4.2.5 Labour Cost	3.4.3.5 Engine Delivery Cost	3.4.4.5 Replace filters	
3.4.1.6 Repeat Survey	3.4.2.6 Profit, Price Calculation	3.4.3.6 Overheads	3.4.4.6 Fill Up with Lubricant	3.4.6.2 Collect payment according to prior agreement.
Confirm instruction and payment agreement with customer	3.4.2.7 Service Price	3.4.3.7 Profit, Price Calculation	3.4.4.7 Fill Up with Coolant	
	3.4.2.8 Compare Prices	3.4.3.8 Total Price, Detailed	3.4.4.8 Prepare Vehicle for Delivery	

KNOWLEDGE: OHS. Survey methods and techniques. Quotation procedure. Engine replacement procedure. Engine construction and operation. Lubricant specifications and identification. Coolant composition, function of additives. Pressurised cooling systems. Importance of temperature control and normal operating temperature. Invoicing and basics of accounting.

SKILLS: Safety. Survey execution. Engine replacement. Engine and vehicle preparation for operation. Quotation compilation.

VALUES: Communication etiquette, respect for and empathy with client, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Entrepreneurial skills. Customer confidence. Communication skills. Verbal, written reports to customer. Motor vehicle performance and economy. New engine registration procedures.

MS3 - 3.6 GEARBOX REPLACEMENT

February 2011

Unit Standard Outcomes:	Learners can read the procedure from workshop manual, follow the study guide and safely replace a motor vehicle gearbox. Learners can do the inspections, write a report and complete a job card according to the procedure. Learners can explain the procedures to follow with front and rear wheel drive vehicles verbally and in writing using grammatically correct language.
Curriculum Outcomes:	Demonstrate ability to learn and employ techniques to improve learning capacity. Demonstrate the ability to transfer knowledge from a specific task to differing applications. Learners demonstrate appreciation of property, tidiness and interpersonal interaction.
Critical Outcomes:	Communicate effectively using visual, symbolic and/or language skills in various modes. Collect, analyse, organise and critically evaluate information. Explore education and career opportunities.

Knowledge Foundation: OHS. Tools and equipment. MS1-7.3, MS2-5.2 and 3 Gearbox replacement procedures, front and rear wheel drives. Interactions with customers. Language, mechanics, mathematics.

Learner Activities: Opportunity hunting. Learners prepare a quotation for the customer. Replace gearbox. Prepare the vehicle for delivery.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while demonstrating and discussing gearbox replacement - FWD and RWD.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

3.4.1 MARKET SURVEY - DEMAND	3.4.2 COST, PRICE CALCULATIONS	3.4.3 QUOTATION	3.4.4 ENGINE REPLACEMENT	3.4.5 MARKETING
3.4.1.1 Survey Plan - Type, Method	3.4.2.1 Parts Quotations (Provider)	3.4.3.1 Parts Quotations (Provider)	3.4.4.1 Remove Gearbox	3.4.5.1 Method of Marketing
3.4.1.2 Target Population	3.4.2.2 Accessories Quotations (Provider)	3.4.3.2 Accessories Quotations (Provider)	3.4.4.2 Clean Gearbox, Vehicle	
3.4.1.3 Survey Execution	3.4.2.3 Cost Calculations	3.4.3.3 Cost Calculations	3.4.4.3 Vehicle Inspection, Preparation	3.4.6 INVOICING, COLLECTION
3.4.1.4 Survey Analysis, Conclusion	3.4.2.4 Time Schedule	3.4.3.4 Time Schedule, Labour Costs	3.4.4.4 Mount (replacement) Gearbox	3.4.6.1 Deliver invoice according to prior agreement.
3.4.1.5 Change Target Population (Alt)	3.4.2.5 Labour Cost	3.4.3.5 Gearbox Delivery Cost	3.4.4.5 Replace Controls	
3.4.1.6 Repeat Survey	3.4.2.6 Profit, Price Calculation	3.4.3.6 Overheads	3.4.4.6 Fill Up with Lubricant	3.4.6.2 Collect payment according to prior agreement.
Confirm instruction and payment agreement with customer	3.4.2.7 Service Price	3.4.3.7 Profit, Price Calculation	3.4.4.7 Check Gearbox Operation	
	3.4.2.8 Compare Prices	3.4.3.8 Total Price, Detailed	3.4.4.8 Prepare Vehicle for Delivery	

KNOWLEDGE: OHS. Survey methods and techniques. Quotation procedure. Gearbox replacement procedure. Gearbox construction and operation. Lubricant specifications and identification. Reasons for specific lubricant. Functions of a gearbox. Gearbox care and gear changing speeds. Importance of speed when changing down - synchroniser abuse. Invoicing and basics of accounting.

SKILLS: Safety. Survey execution. Gearbox replacement. Gearbox and vehicle preparation for operation. Quotation compilation.

VALUES: Communication etiquette, respect and empathy with client, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Gearbox operation. Synchromesh function, construction and operation. Synchromesh uses and abuses. Gearbox lubrication features. Calculation of gear ratios and road speeds. Entrepreneurial skills. Customer confidence. Communication skills. Verbal, written reports to customer. Driving habits and gearbox care.

MS3 - 4.1 ENGINE REPLACEMENT

February 2011

Unit Standard Outcomes: Learners can follow the correct procedure to remove and mount the engine in the vehicle.
Learners can mount the support components in the vehicle and connect them correctly.
Learners can prepare an engine and vehicle for first time starting.
Learners can explain the procedures verbally and in writing using grammatically correct language and spelling, do mathematical, mechanics calculations.

Curriculum Outcomes: Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety, MS1-1.2 Tools, MS1-2.3 Engine Hoist, MS1-6.1 Vehicle Layout. MS1-6.5, MS1-6.6, MS1-6.7, MS1-6.8, MS1-7.1, MS1-7.2, MS2-5.4.
Trigonometry. Mechanics. Language.

Learner Activities: Active participation: remove and mount engine. Mount support components. Follow the procedure in preparing engine for starting and double checking work done. Assess engine running operation. Take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Transdisciplinary integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

4.1.1 PREPARATION PLAN	4.1.2 REMOVE ENGINE	4.1.3 MOUNT ENGINE	4.1.4 ENGINE PREPARATION	4.1.4 WRAPPING UP
4.1.1.1 Procedure Plan	4.1.2.1 Remove Battery	4.1.3.1 Lower Engine onto Mountings	4.1.4.1 Fit Engine Filters	4.1.4.1 Start Engine
4.1.1.2 Lay Out Tools and Equipment	4.1.2.2 Remove Radiator, etc.	4.1.3.2 Mount Gearbox on Engine	4.1.4.2 Put Lubricant into the Engine	4.1.4.2 Check Oil Pressure
4.1.1.3 Vehicle Preparation	4.1.2.3 Detach, Secure Gearbox	4.1.3.3 Fasten Engine Mountings	4.1.4.3 Put Coolant into the Radiator	4.1.4.3 Check Engine Operation
4.1.1.4 Engine Preparation	4.1.2.4 Detach Engine Mountings	4.1.3.4 Mount Radiator, Components	4.1.4.4 Top Up Gearbox Lubricant	4.1.4.4 Check for Leaks
4.1.1.5 Hoisting Procedure	4.1.2.5 Pull Engine out Carefully	4.1.3.5 Mount Support Components	4.1.4.5 Go Through Check Procedure	4.1.4.5 Clean, Put Away Tools
4.1.1.6 Gearbox Support/Removal	4.1.2.6 Attach Engine to Engine Stand	4.1.3.6 Mount Battery	4.1.4.6 Prepare Engine for Starting	4.1.4.6 Clean Worksite

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Engine components, functions, care. Procedure and techniques to replace gearbox on engine and engine in vehicle. Safety, procedures and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures of removing and mounting gearbox on engine, engine in vehicle and support components. Job card completion.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Engine operation. Engine timing. Clutch function, construction and operation. Engine performance features. Mathematics: arithmetic, algebra, trigonometry.

MS3 - 4.2 GEARBOX REPLACEMENT

Unit Standard Outcomes: Learners can read safety rules and gearbox replacement procedures from study guides and/or manuals.
Learners can select the correct tools and equipment and follow the correct procedure to replace the gearbox.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.
Learners can explain basic gearbox operation, do calculations: math/mechanics: ratios, force, and torque.

Curriculum Outcomes: Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure.
Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1 Safety, MS1-1.2 Tools, MS1-2.2 Vehicle Hoist, MS1-2.4 Gearbox Jack. MS1-6.1 Vehicle Layout. MS1-7.1 Remove Starter. MS1-7.3 Remove Gearbox RWD. MS1-8.5 Gear Drives. Language. Mathematics. Mechanics.

Learner Activities: Active participation: put vehicle on lift, detach and remove gearbox. Prepare gearbox for dismantling. Mount the gearbox. Prepare vehicle for delivery. Take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

4.2.1 PREPARATION PLAN	4.2.2 DEMOUNT, REMOVE GEARBOX	4.2.3 MOUNT GEARBOX	4.2.4 WRAPPING UP OPERATIONS
4.2.1.1 Procedure Plan (Manual/Study Guide)	4.2.2.1 Detach Driving Shafts	4.2.3.1 Slide Gearbox Shaft carefully into Clutch	4.2.4.1 Double Check Work Done
4.2.1.2 Site Preparation	4.2.2.2 Remove Starter	4.2.3.2 Mount Gearbox on Engine and Mounting	4.2.4.2 Check Smooth Selection of Gears
4.2.1.3 Select Equipment and Tools	4.2.2.3 Detach Controls and Monitors	4.2.3.3 Mount Starter	4.2.4.3 Check Clutch Operation
4.2.1.4 Lift Vehicle with Hoist, Secure	4.2.2.4 Support Engine with Jack and Cradle	4.2.3.4 Remove Jack and Cradle	4.2.4.4 Run the Gearbox and Evaluate
4.2.1.5 Drain Lubricant	4.2.2.5 Detach Gearbox from Engine, Mounting	4.2.3.5 Attach Driving Shafts	4.2.4.5 Prepare Vehicle for Delivery
4.2.1.6 Clean Gearbox, Body Area	4.2.2.6 Remove Gearbox from Vehicle	4.2.3.6 Attach Controls and Monitors	4.2.4.6 Clean, Put Away Tools and Equipment
	4.2.2.7 Check Clutch Parts, Release Bearing	4.2.3.7 Fill Gearbox with Prescribed Lubricant	4.2.4.7 Clean Worksite

KNOWLEDGE: OHS. Tools and equipment, purposes, use. Gearbox/gearbox-final drive assembly, functions, construction, operation. Gear ratios and speed calculations. Gear ratios and torque calculations. Compare sacrifice of speed and torque gain. Safety, procedures and recording.

SKILLS: Safety procedures, handling of tools and equipment. Execution procedures. Replace gearbox.

VALUES: Communication etiquette, respect for and empathy with peers, honesty, dedication. Personal and people safety. Meticulous execution of tasks. Value property and equipment.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Mathematics: arithmetic, manipulation of formula. Mechanics: gears and ratios, compilation of formula for torque and speed calculations. Simplification of formula - eliminating redundant elements. Clutch function, construction and operation.

MS3 - 4.3 ENGINE DISMANTLING

February 2011

Unit Standard Outcomes:	Learners can identify parts; know their functions, construction, material and basic properties. Explain reasons for cooling and lubrication. Learners can read safety rules and procedures from study guides and/or manuals and reflect on them. "Read" sketches and exploded views. Learners can select the correct tools and equipment and follow the correct procedure to remove the parts. Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling. Learners can do mathematical, scientific, mechanics calculations related to the operations executed, e.g. torque, surface area, displacement.
Curriculum Outcomes:	Demonstrate ability to plan and execute assignments effectively complying to OHS regulations and prescribed procedure. Demonstrate the ability to transfer knowledge from a specific task to differing applications. Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations. Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.
Critical Outcomes:	Identify and solve problems and make decisions using critical and creative thinking. Organise and manage themselves and their activities responsibly and effectively. Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1Safety, MS1-1.2 Tools, MS1-2.3 Engine Hoist, MS1-5.1 Vehicle Layout, MS1-4.1 Metal Knowledge, MS1-6.1 Lubrication, MS1-4 Cooling System Maintenance. Arithmetic, formula, calculations, language.

Learner Activities: Dismantle an engine according to procedure. Take notes of information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

7.1.1 PREPARATION AND PLAN	7.1.2 DISMANTLING PROCEDURE	7.1.3 DISMANTLE CYLINDER HEAD	7.1.4 WRAPPING UP PROCEDURE
7.1.1.1 Carefully Study Procedure	7.1.2.1 Remove Timing Belt/Chain	7.1.3.1 Remove Camshaft	7.1.4.1 Clean Parts, Keep Pairs Together
7.1.1.2 Tool, Parts Tables, Equipment	7.1.2.2 Remove Rockers (some engines)	7.1.3.2 Remove Rockers/Cam Followers	7.1.4.2 Remove Carbon, Sludge Deposits
7.1.1.3 Mount Engine on Engine Stand	7.1.2.3 Remove Cylinder Head (Examine)	7.1.3.3 Prepare Valve Rack, Number	7.1.4.3 Clean Ring Grooves
7.1.1.4 Drain Lubricant, Remaining Water	7.1.2.4 Remove Sump	7.1.3.4 Number the Valves	7.1.4.4 Prevent Scratching of Faces/Parts
7.1.1.5 Unscrew Oil Filter, Avoid Spilling	7.1.2.5 Remove Oil Pump	7.1.3.5 Remove Valve Springs, Valves	7.1.4.5 Remove Remnants of Gaskets
7.1.1.6 Remove Carburettor, Fuel System	7.1.2.6 Check Connecting Rod Numbering	7.1.3.6 Examine Valves, Seats, Ports	7.1.4.6 Orderly Lay Out Parts
7.1.5.7 Remove Clutch Assembly	7.1.2.7 Remove Pistons and Con Rods	7.1.3.7 Identify Cylinder Head Bolts/Studs	7.1.4.7 Clean Tools and Equipment
7.1.5.8 Strip the Engine of Accessories	7.1.2.8 Remove Flywheel	7.1.3.8 Remove Studs if Required	7.1.4.8 Clean Work Areas, Surfaces
Remember specific procedure!	7.1.2.9 Remove Crankshaft [Examine All]	7.1.2.10 Remove Piston Rings, Bearings	7.1.4.9 Put Away Tools, Equipment

KNOWLEDGE: OHS. Tools, purposes, use. Engine parts, functions, constructions, role of lubrication and cooling, care. Weight, force, mass and pressure. Heat, temperature, energy, measurements and calculations. Safety, procedures, acquisition and recording.

SKILLS: Safety procedures, handling of tools and equipment. Engine dismantling procedures. Methods to care for engine parts.

VALUES: Communication etiquette, respect and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA:
Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Specifics of valve and ignition timing. Condition of parts related to engine performance and durability. Reasons for damage to parts and prevention.

MS3 - 4.4 ENGINE ASSEMBLY PREPARATION

February 2011

Unit Standard Outcomes: Learners can identify parts; know their functions, construction, material and basic properties. Explain reasons for cooling and lubrication.
Learners can read safety rules and procedures from study guides and/or manuals and reflect on them. "Read" sketches and exploded views.
Learners can select the correct tools and equipment and the correct procedure to assemble the engine.
Learners can explain the properties and procedures verbally and in writing using grammatically correct language and spelling.

Curriculum Outcomes: Demonstrate the ability to transfer knowledge from a specific task to differing applications.
Reveal critical thinking through sensible reasoning, logical conclusions and practicable decisions in difficult situations.
Demonstrate capacity to operate in workplace and sensitivity towards environmental issues, e.g. disposal of used lubricants, filters and chemicals.

Critical Outcomes: Identify and solve problems and make decisions using critical and creative thinking.
Organise and manage themselves and their activities responsibly and effectively.
Work effectively with others as members of a team, group, organisation and community.

Knowledge Foundation: MS1-1.1Safety, MS1-1.2 Tools, MS1-5.1 Vehicle Layout, MS1-4.1 Metal Knowledge, MS1-6.1 Lubrication, MS1-4 Cooling System Maintenance, MS3-4.3 Engine Dismantling. Parts, construction material and properties. Arithmetic, formula, calculations, language.

Learner Activities: Active participation: study assembly procedure. Prepare parts and components for assembly and assist artisan in precautionary checks and measurements. Take notes on information provided, reflect verbally, write a report on the information and proceedings.

Presentation policy: Learning by doing - learners acquire knowledge, skills and values while working with their hands. Fully integrated.

Theoretical Foundation: Constructivist education - learners construct their own mental representations of information on existing (prior) knowledge.

4.4.1 PREPARATION AND PLAN	4.4.2 PARTS PREPARATION	4.4.3 ARTISAN ASSISTANCE	4.4.4 WRAPPING UP PROCEDURE
4.4.1.1 Study Assembly Procedure (Manual)	4.4.2.1 Unwrap Parts, Check with Order	4.4.3.1 Check Ring Gap	4.4.4.1 Wrap Parts, Components: Dust Free
4.4.1.2 Select Required Tools, Equipment	4.4.2.2 Clean Parts	4.4.3.2 Check Ring Groove Clearance	4.4.4.2 Record Checking Procedure
4.4.1.3 Mount Block on Engine Stand	4.4.2.3 Arrange Parts According to Sequence	4.4.3.3 Check Ring Orientation	4.4.4.3 Record Readings and Measurements for Later Reference
4.4.1.4 Arrange Engine Accessories, Easy Access	4.4.2.4 Clean Engine Block	4.4.3.4 Check Oil Clearance	
4.4.1.5 Check, Arrange Support Components	4.4.2.5 Check Oil Passages	4.4.3.5 Check Bearing Nip/Crush	4.4.4.4 Get Clean Engine Oil for Assembly
4.4.1.6 Ensure Clean, Obstacle-free Work Area	4.4.2.6 Check Surfaces	4.4.3.6 Check Crankshaft End-play	4.4.4.5 Prepare Gaskets and Packings
	4.4.2.7 Check Welch Plugs	4.4.3.7 Check Cylinder Head Distortion	4.4.4.6 Keep Workshop Manual and Other Specifications Handy
	4.4.2.8 Check that all Parts, Components are Available and within Reach	4.4.3.8 Check Piston Orientation	
		4.4.2.9 Check and Prime Oil Pump	

KNOWLEDGE: OHS. Tools, purposes, use. Engine parts, functions, constructions, role of lubrication and cooling, care. Value of specifications and procedures. Measurements and calculations. Safety procedures, acquisition and recording.

SKILLS: Safety procedures, handling of tools and equipment. Engine assembly procedures. Arrange parts components, tools and equipment according to procedure. Methods to care for engine parts.

VALUES: Communication etiquette, respect and empathy with peers. Personal and people safety. Value equipment and tools.

ASSESSMENT CRITERIA: Provision for different levels of accomplishment according to Bloom's taxonomy: Remember, Understand, Apply, Analyse, Create and Evaluate.
Continuous observation and recording of learner participation and performance.
Formative assessment in the form of instant written tests and/or verbal questions, written reports, execution of tasks.
Summative assessment to verify accomplishment of outcomes and execution of tasks.
Verify comprehension, competence and knowledge retention.
Determine significance of the learning content to the learners.
Determine learner perspective - relevance and relationships within curriculum context.

LINKS: Importance of procedure and specifications. Specifics of valve and ignition timing. Design of parts related to engine performance and durability.

CURRICULUM EVALUATION CRITERIA

The primary concerns with curriculum design are feasibility and credibility, which involves procedural efficiency and content validity. A rating scale with five levels is used for the curriculum benchmarking, enabling assessment of value and progression in the external evaluation.

The scale ranges from 5 to 1 with 5 representing the highest positive value and 1 the lowest.

Feasibility scale: To what extent does curriculum meet the programme criteria listed?

5	Excellently
4	Largely
3	Reasonable
2	Fairly
1	Barely

Please tick the relevant value. √

1.	Curriculum meets the requirements of an introductory technical education course	√	4	3	2	1
2.	Curriculum meets the requirements of lower level skills occupations (assistants*)	5	√	3	2	1
3.	Curriculum meets the requirements of a bridging course into learnerships	5	√	3	2	1
4.	Curriculum meets the requirements of a bridging course into apprenticeships	√	4	3	2	1
5.	Curriculum meets the requirements of a bridging course into NC(V)	5	√	3	2	1
6.	Curriculum meets the requirements of competency for micro-entrepreneurships	5	√	3	2	1
7.	The curriculum is practicable - based on a sound executable concept	5	√	3	2	1
8.	The curriculum fills a gap between school education and technical education	5	√	3	2	1
9.	The curriculum is educator friendly - clear, unambiguous, informative	√	4	3	2	1
10.	Units are linked into a significant whole	5	√	3	2	1

*e.g. artisans' assistants, component fitters, unit strippers

Credibility scale: To what extent does curriculum meet the learning criteria listed?

5	Excellently credible
4	Highly credible
3	Meet the requirements
2	Fairly meet the minimum requirements
1	Barely meet the minimum requirements

Please tick the relevant value. √

1.	The curriculum covers the curriculum outcomes	√	4	3	2	1
2.	The curriculum covers the critical cross-field outcomes	5	√	3	2	1
3.	The curriculum covers the personal developmental outcomes	5	√	3	2	1
4.	The context of the curriculum offers real life practices	√	4	3	2	1
5.	The curriculum makes provision for language development	5	√	3	2	1
6.	The curriculum makes provision for mathematical development	5	√	3	2	1
7.	The curriculum makes provision for science development	5	√	3	2	1
8.	The curriculum complies with transdisciplinary curriculum integration principles	5	√	3	2	1
9.	The curriculum sufficiently links prior knowledge to new information	√	4	3	2	1
10.	The curriculum makes provision for integrated knowledge and skills acquisition	√	4	3	2	1
11.	The curriculum offers practical-based education extending into further knowledge	√	4	3	2	1
12.	The curriculum offers multi-sensory learning opportunities	5	√	3	2	1
13.	The curriculum makes provision for group work	5	√	3	2	1
14.	The curriculum requires learner involvement and practical hands-on activities	√	4	3	2	1
15.	The curriculum incorporates comprehensive summative continuous assessment	5	√	3	2	1
16.	The curriculum incorporates formative, continuous assessment and observation	5	√	3	2	1
17.	Assessment criteria are adequately specified	5	√	3	2	1
18.	The curriculum can facilitate effective learning: knowledge, skills and values	5	√	3	2	1
19.	The curriculum is focussed	√	4	3	2	1
20.	The curriculum makes provision for summative and formative assessment	5	√	3	2	1

After consensus has been reached, the adaptations will be made and recommendations added.

Thank you for participating in the project.

COMMENTS:
Great work done! Congratulations!
RECOMMENDATIONS:

LEARNING OPPORTUNITY FRAMEWORK

- Fundamentals
    - Educational principles and premises
    - How learners learn best – fundamental theory
    - The best fundamental structure (learning context) for effective learning – transdisciplinary integrated approach
    - The best presentation strategy for the specific learning content
    - Best methods and techniques in conjunction with outcomes
- Learning to be accomplished
    - Unit standard outcomes
    - Curriculum outcomes applicable
    - Critical and personal development outcomes applicable
- Learner activities and contributions to the learning opportunity
    - Prepare in advance for the learning opportunity
    - Participate in the practicum
    - Individual responsibilities in the event
- What the educator brings to the occasion
    - His own constructs of reality – declarative knowledge
    - Skills – procedural knowledge
    - Personality
- What the learners bring to the occasion
    - Bio-psychological potential
    - Relevant internalised knowledge (existing mental representations)
    - Procedural knowledge (skills)
    - Personal expectations
    - Educational expectations
    - Educational predisposition
    - Personality
    - Culture, including mother tongue language
- Learners' families in support of education
    - Cultural values
    - Learning opportunities – exposure to information, experiences and guidance
    - Educational values
    - Personal expectations
    - Educational expectations

  - Financial support
  - Moral support
- FET colleges
  - Organisational and managerial support
  - Facilities (venue)
  - Curriculum and related documentation
  - Equipment
  - Material and consumables
  - Teaching aids
  - Literature and documents (Gardner, 1993:122, 123).

LEARNING OPPORTUNITY SKELETON

- Results of the situation analysis
- Unit standard title and number
- Topic of the learning opportunity
- Outcomes to be achieved differentiated into knowledge, skills and values
- Curriculum outcome(s) incorporated
- Critical cross-filed outcome(s) incorporated
- Mind preparation: required prior knowledge – launch pad

  Links between prior knowledge and new information

  Techniques to establish curiosity
- Learning content required
- Teaching strategies: methods, techniques and application
- The hardware – components, equipment, documents (papers), support material (media, appliances)
- Method and instruments for recording events and learning proceedings (e.g. rubrics)
- Reinforcement of knowledge, skills and values
- Assessment – assessment criteria (unit standard)

  Assessment instruments

  Recording instruments
- Conclusion
- Venue preparation plan and layout sketch

LEARNING OPPORTUNITY BENCHMARK

- Educator
  - Learning opportunity preparation
  - Venue preparation
  - Presentation
  - Assessment
  - Documentation
- Management
  - Educator support and encouragement
  - Monitoring education
- Facilities
  - Suitability
  - Learner comfort
- Equipment
  - Meet minimum requirements of the practicum
  - Condition
- Teaching media
  - Meet minimum requirements of the practicum
  - Condition
- Learners
  - Dedication
  - Participation
  - Determination
  - Perseverance
  - Behaviour
  - Portfolio of evidence

1 APPENDIX O

TEACHING STYLES

The different types of teaching style identified by Mishra's (2007:2, 3), are:

- discipline-centred teaching style, which is dominated by the subject/field and learning content;
- educator-centred teaching, which is similar to the formal authority where the formal lecture is the dominant modus operandi. The educator is the main source of information. Significant objections to this method are the passive learner and (possible) notion of the "empty vessel";
- student-centred teaching is focused on the learners, learner activity, and construction of knowledge and learners' development.

These are also familiar in didactic terminology. The kinds of knowledge expected of educators are:

- subject content;
- the best teaching strategies to present the subject content; and
- how learners learn – fundamental learning theory.

A different set of teaching styles, which appear frequently in educational literature and also surfaced in the interviews, show some correlation with the previous list:

- Direct instruction/formal authority (authoritarian) is educator-centred and lecture-orientated. The educator is the main source of information.
- Demonstrator or personal model is educator-centred with the educator as a role model and leader. The natural teaching method is demonstration with application by the learners.
- Coach or facilitator style (indirect instruction), a learner-centred approach focuses on learner activities and participation.
- Delegator style (self-directed instruction) operates on learner responsibility and selected control over learning and activities.