A PEDAGOGICAL PERSPECTIVE ON THE ANNUAL NATIONAL ASSESSMENT TESTS IN GRADE 9 MATHEMATICS

S.K. SPIES

Dissertation submitted in the fulfilment of the requirements for the degree

MASTERS IN EDUCATION

in

CURRICULUM STUDIES

in the

SCHOOL OF EDUCATION STUDIES

FACULTY OF EDUCATION

at the

UNIVERSITY OF THE FREE STATE

BLOEMFONTEIN

Supervisor: Prof. G.F Du Toit

January 2016

ETHICS APPROVAL OF PROJECT

Faculty of Education
Ethics Office
Room 12
Winkie Direko Building
Faculty of Education University of the Free State
P.O. Box 339
Bloemfontein 9300
South Africa
T: +27(0)51 401 9922
F: +27(0)51 401 2010
www.ufs.ac.za BarclayA@ufs.ac.za

18 August 2014

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With reference to your application for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Ethics Board of the faculty that you have been granted ethical clearance for your research with the following stipulations (comments by reviewers):

- It is still somewhat unclear how the learners will be selected – this could be clarified.
- I do not believe the letter to the parents clearly explains what will be expected of the learners. Please modify the letter.
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Yours sincerely,

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I, Lorene van Wyk (M.A. Language Practice), declare that I have done the language and technical editing of this document to the best of my ability.

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ACKNOWLEDGEMENTS

I could not have written this dissertation without the help of the people who supported me. In particular, I would like to express my sincere gratitude to the following persons:

- My Heavenly Father, it is only through His grace that I was able to persevere and complete this study;
- My supervisor, Prof. G.F. du Toit, for his generous support, guidance, motivation and encouragement;
- Lorene van Wyk, who assisted me with the language editing;
- Dr. Nola Redelinghuys, words fail me when I have to think of your valuable contribution and support;
- The Department of Basic Education who gave me permission to do research at schools;
- Principals, teachers, learners who participated in this research project;
- My father and late mother for my upbringing, guidance and motivation;
- My children Ninke, Liam and Elri who understood when I did not have time to spend with them.

“Education is the most powerful weapon which you can use to change the world”

Nelson Mandela

SUMMARY

Teaching, learning and assessment of Mathematics in South African schools is interspersed with problems and inadequacies. National tests have shown that South African learners do not have the Mathematical knowledge and skills that are expected of a Grade 9 learner.

The aim of this study was to investigate the nature and extent of the influence of the ANA on the Mathematics pedagogy in Grade 9 classrooms. The achievement of the aim was facilitated by the achievement of a number of objectives.

The study investigated Grade 9 Mathematics teachers' and learners' view and interpretation of teaching, learning and assessment and determined to what extent the ANA has an influence on the Mathematics pedagogy in a Grade 9 Mathematics classroom.

This study utilized a qualitative research approach. The data was collected using three data collection strategies namely interviews with five teachers; focus-group interviews with learners and document analyses of various documents. The population of this study consisted of all schools teaching Grade 9 Mathematics in the General Education and Training (GET) phase in the Free State Province. The sampling decisions were made specifically for the explicit purpose of obtaining the best possible source of information to respond to the research questions. All educators were selected on the basis that they were qualified to teach Mathematics and had at least one year of 'ANA experience'.

The interpretation of the data showed that teachers were pressurized to complete the work schedule before the ANA test was written in September 2014. The intended purpose of the ANA test, as envisioned by the Department of Basic Education is pure. However, it may be sensible to let the learners write the ANA test later on in the year or at the start of the next year.

The work schedule specified in the CAPS document of the Department of Basic Education is too wide-ranged. This contributed to uncertainty on what can be tested in the ANA test.

Most of the teachers interviewed did not focus on the ANA test as such, they continued with the syllabus. Teachers had a negative perspective towards the ANA test and this negative

perception streamed down towards the learners. The teachers' and learners' responses indicated that most of the learners saw the ANA test as unimportant because the ANA test did not count towards their final grade. This was reflected in the marks of the ANA 2014 test.

Feedback on the ANA 2014 test was questionable. Because of this, various shortcomings were identified regarding feedback on the ANA. The majority of teachers did not receive the Diagnostic Report from the Department of Basic Education and therefore could not assist learners with proper feedback on areas of weakness and areas of strength.

Assessment was not executed on the appropriate cognitive levels by all schools. Some teachers concentrated on factual answers that had little to do with developing creative thinking and creative abilities that could provide learners with opportunities to practice Mathematics and answer higher level questions. Teachers align their teaching-learning and assessment processes in the Grade 9 Mathematics classroom but the poor performance in the ANA test together with the inefficient knowledge of Grade 9 Mathematics learners might be an indicator that what is expected of learners does not align with the teaching, learning and assessment in the Grade 9 Mathematics classroom.

OPSOMMING

Suid-Afrikaanse skole ervaar probleme met die onderrig, leer en assessering van Wiskunde. Nasionale toetsing van Graad 9-leerders het aangedui dat hierdie leerders nie beskik oor die nodige/basiese Wiskunde kennis en vaardighede nie.

Die doel van hierdie studie was om die aard en omvang van die invloed van die “ANA”-toets op die Wiskunde pedagogiek in graad 9-Wiskunde klasse te ondersoek. Die doel is gefasiliteer deur die bereiking van verskeie doelwitte.

Die studie het graad 9-Wiskunde onderwysers en leerders se siening en interpretering van onderrig, leer en assessering ondersoek om te bepaal tot watter mate “ANA” die Wiskunde pedagogiek in die graad 9-Wiskunde klaskamer beinvloed.

In die studie is gebruik gemaak van ‘n kwalitatiewe navorsings benadering. Data is versamel deur middel van drie data-insamelingstrategieë naamlik onderhoude met vyf onderwysers, onderhoude met leerders in fokusgroepe en ‘n dokumentanalise van verskeie dokumente. Die populasie van die studie bestaan uit skole wat Graad 9 Wiskunde leerders onderrig in die ‘General Education and Training’ (GET) fase in die Vrystaat. Die doel van die keuse van die steekproef was die verkryging van die beste moontlike bron van inligting om te reageer op die navorsingsvraag. Onderwysers is gekies op die basis dat hulle gekwalifiseerd is om Wiskunde te kan onderrig en ten minste 1 jaar ‘ANA-ervaring’ het.

Daar is tot die gevolgtrekking gekom dat onderwysers onder druk geplaas word om die werkskedule te voltooi voordat die “ANA”-toets in September 2014 geskryf is. Die beoogde doel van die ANA soos deur die Departement in die vooruitsig gestel was, is suiwer. Dit kan egter raadsaam wees om leerders die “ANA” later in die jaar of aan die begin van die volgende jaar te laat skryf.

Die werkskedule gespesifiseer in die KABV-dokument van die Departement van Basiese Onderwys is wyd omskryf. Dit lei tot ‘n onsekerheid by onderwysers oor die inhoud wat in die “ANA” getoets kan word.

Meeste van die onderwysers in die studie het gefokus op die leerplan en nie sodanig op die “ANA”-toets nie. Dit kan afgelei word dat hierdie negatiewe persepsie van die ANA deur filter

na die leerders toe. Uit die onderhoude met onderwysers en leerders is afgelei dat meeste leerders die “ANA” as onbelangrik ervaar aangesien dit nie verreken word in hulle finale punte nie. Leerders erken nie die belangrikheid van die “ANA”-toets nie en dit word ook gesien in die analise van die toets/eksamens van die skole in die studie asook die “ANA” 2014-toets.

Daar is ook twyfel oor die terugvoer van die “ANA” 2014-toets. As gevolg van die swak terugvoer van die “ANA” 2014-toets is tekortkominge geïdentifiseer rakende die terugvoer van die “ANA”. Meeste van die onderwysers in hierdie studie het nie die Diagnostiese Verslag van die Departement van Basiese Onderwys ontvang nie en leerders kon dus nie gehelp word met die nodige terugvoer oor hul sterk- en swakpunte nie.

Die analise van die toets/eksamenvraestelle van die skole in die studie toon dat nie alle skole die toepaslike kognitiewe vlakke toets nie. Onderwysers konsentreer op feitlike vrae wat min te doen het met die ontwikkeling van die kreatiewe denke en kreatiewe vermoëns van leerders wat leerders kan voorsien van geleenthede om Wiskunde te oefen en om hoërvlak vrae te beantwoord. Alhoewel onderwysers hulle onderrig, leer en assessering in die graad 9-Wiskunde klaskamer belyn is die swak “ANA”-toets uitslae saam met onvoldoende kennis van die graad 9-Wiskunde leerder moontlik ‘n aanduiding dat belyning van onderrig, leer en assessering nie in die graad 9-Wiskunde klaskamer plaasvind nie.

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LIST OF ABBREVIATIONS

AIDS	Acquired immune deficiency syndrome
ANA	Annual National Assessment
CAPS	Curriculum and Assessment Policy Statement
CASS	Continuous Assessment
CK	Curricular Knowledge
CTAss	Common Tasks for Assessment
DBE	Department of Basic Education
DoE	Department of Education
FET	Further Education and Training
FoE	Faculty of Education
GET	General Education and Training (band)
HIV	Human immune deficiency virus
HOD	Head of Department
LoLT	Language of learning and teaching
NAPLAN	National Assessment Program – Literacy and Numeracy
NASA	National Assessment of Educational Achievement
NCS	National Curriculum Statement
NT	National Test
PCK	Pedagogical Content Knowledge
SACMEQ	Southern and Eastern Consortium for Monitoring Educational Quality
SATs	Standard Assessment Task
SCK	Subject Matter Content Knowledge
SMTs	School Management Teams
TIMMS	Trends in International Mathematics and Science Study
UFS	University of the Free State
ZPD	Zone of Proximal Development

CHAPTER 1

ORIENTATION AND PROGRAMME OF STUDY

The mediocre teacher tells, the good teacher explains, the superior teacher demonstrates and the great teacher inspires.

William A. Ward

1.1 INTRODUCTION

Assessment is a continuous planned process of gathering, identifying and interpreting information concerning the performance of learners.

According to the Department of Basic Education (DBE) (2011:154) assessment involves four steps, namely:

- Generating and collecting evidence of achievement.
- Evaluating this evidence
- Recording the findings.
- Using this information to understand and thereby assist the learner's development in order to improve the process of learning and teaching.

In the last 15 years South African teachers have been exposed to several curriculums, policies, management, monitoring and evaluation changes. In 2001, the Department of Education (DoE) decided to pilot the use of Common Tasks for Assessment (CTASs) in each of the eight learning areas, focusing on the Grade 9 level. The CTASs were developed by teams of learning area experts that were selected from the provincial education departments. In 2003, the CTASs were developed and moderated and it was compulsory for all schools to administer the CTASs in November 2003. According to the National Department of Education, the CTASs were considered as an external summative assessment instrument that could be used to assess the reliability of the internal school-based formative assessments (DoE 2002:4-6; Poliah 2003:6-10).

The CTASs, consisting of a sequence of assessment tasks set within a particular real-life context, were processed for all learners at the end of Grade 9. The learners' written replies to the various tasks would be marked and used to calculate a summative assessment score. The CTASs were an external summative task designed to create an objective assessment of learners' knowledge and skills (Bansilal 2011:91).

The DBE announced by means of circular S1 of 2010 (8 April 2010) that the Grade 9 CTASs were to be discontinued and replaced by the Annual National Assessment (ANA) for Grade 9 in Languages and Mathematics on an annual basis (DBE 2010:8).

Prior to the introduction of the ANA in 2011, assessment in South Africa consisted of school-based assessments (such as the CTASs as mentioned above) and the National Senior Certificate (Grade 12 examination). Several research sources indicated that school-based assessment systems were extremely weak especially in the historical poor (low income) section of the system leading to random grade repetition and wrong subject choices (Lam, Ardington & Leibbrandt 2011:121-136). It was largely in reaction to these problems that the ANA was introduced.

Since 2011, the ANA has provided the DBE with an improved understanding of the impact towards refining Numeracy/Mathematics and Literacy/Language in South African Schools (DBE 2014b:8). According to the DBE (2014b:9) the Grade 9 performance of learners in Mathematics, as in 2012 and 2013, remained below expectation and required further attention. These poor assessment results are a reflection of the crisis facing Mathematics education in South Africa. South African learners tend to achieve below acceptable levels (50% or less) in Mathematics (DBE 2014b:10).

More than half a century ago, Ausubel (1960:267-272) implied that the most important factor of learning is what the learner already knows, and that teachers should determine this, and teach accordingly. An important way in which educators can determine this is through assessment.

It is therefore not a new idea that assessment supports learning. In 1956 Bloom (1984:4-17) recommended that it might be useful to examine the process of effective instruction and evaluation (Bloom *et al.* 1956:62-187). In the late 1980s the theory

stated that classroom assessment practices could be both beneficial and disadvantageous towards learners' learning. During the 1990s the idea was that assessment is an integral part of instruction and that assessment could improve learner outcome (Black & William 1998b:61).

The aim of classroom assessment is to create information that adds to the teaching and learning process and support in educational decision making. Below is a list of principles for classroom assessment according to De Lange (1999:10):

- The main function of classroom assessment is to enhance learning.
- Mathematics is rooted in relevant problems that are part of the learners' real world and should thus be assessed accordingly.
- Methods of assessment should enable learners to expose what they know, rather than what they do not know.
- A balanced assessment plan should include multiple chances for learners to present their achievements.
- Assessment tasks should include all areas of the curricula.
- The assessment process should be open to learners.
- Feedback to learners should be compulsory.

In 2011, the DBE introduced ANA in Language and Mathematics for Grades 1 to 6. In 2012 the ANA was extended to Grade 9. Since 2011 all Grade 9 learners in public schools have written the ANA tests according to a nationally-set timetable. The tests cover knowledge and skills accumulated during the particular school year. The ANA is currently (2015) in its fourth year of implementation.

In 2012 the average percentage achieved in the ANA by Grade 9 learners in the Free State Province was 14% and in 2013, 15.3% (DBE 2014b:61). The DBE agreed to an independent agent to report the reliability of the ANA scores. An independent agent had to verify that test administration and marking took place in line with acceptable levels. In each school the independent agent moderated a sample of scripts of each school. The verification findings showed the moderated scripts of the independent agent (administered across a selected sample of schools). In 2014 the average percentage of

Grade 9 learners in the Free State Province was 12.9% (universal) and 13.8% (verification)(DBE 2014b:61). This performance was extremely poor and below expectation and according to the DBE this required further attention (DBE 2013:33).

Learner achievement is expressed in terms of seven levels of achievement specified in the Curriculum and Assessment Policy Statement (CAPS) in Grade 9. The levels and descriptors are shown in the table below (DBE 2013:57).

Table 1.1: Seven levels of achievement

Rating Code	Percentage	Descriptor
Level 1	0-29	Not achieved
Level 2	30-39	Elementary achievement
Level 3	40-49	Moderate achievement
Level 4	50-59	Adequate achievement
Level 5	60-69	Substantial achievement
Level 6	70-79	Meritorious achievement
Level 7	80-100	Outstanding achievement

DBE (2013:57)

According to the table above, high achievement of learners was believed to include levels 5 to 7.

In 2012, 3.1% of Grade 9 learners in the Free State Province achieved acceptable levels (levels 4 to 7) in Mathematics, while in 2013 only 4.1% of Grade 9 learners in the Free State Province achieved acceptable levels in Mathematics (DBE 2012:44; 2013:62; 2014b:81). In 2014, 4% (universal) and 5.1% (verification) of Grade 9 learners in the Free State Province achieved acceptable levels (levels 4 to 7) in Mathematics (DBE 2014b:71). There was a slight increase in the achievement of learners between 2012 and 2014.

Table 1.2: Percentage of Grade 9 Mathematics learners' in the Free State Province achievement levels in 2013 and 2014

Rating Code	2013	2014
Level 1	86.9	87.8
Level 2	5.6	4.6
Level 3	3.4	3.6
Level 4	1.9	2.0
Level 5	1.1	1.1
Level 6	0.6	0.5
Level 7	0.5	0.3

DBE (2013:62; 2014b:81)

According to the table above, 86.9% of learners in the Free State Province in 2013 and 87.8% of learners in 2014 reached the not-achieved level in Grade 9 Mathematics. 2.2% of learners in the Free State Province in 2013 and 1.9% of learners in 2014 accomplished high achievement levels (levels 5 to 7).

1.2 PROBLEM STATEMENT

Evidence, as shown in the literature cited above, revealed that the teaching and learning of Grade 9 Mathematics learners in South African schools is interspersed with problems and inadequacies, resulting in low achievement in Mathematics. Based on this the over-arching question that can be asked is: *What is the nature and extent of the ANA's influence on the pedagogy in the teaching and learning of Mathematics at Grade 9 level?*

The following secondary questions were asked:

- Does the ANA have an influence on the teaching of Mathematics in a Grade 9 Mathematics classroom?
- Does the ANA have an influence on the learning of Mathematics in a Grade 9 Mathematics classroom?

- Does the ANA have an influence on assessment in a Grade 9 Mathematics classroom?
- Is the implementation of the ANA aligned with the intention of the designers of the ANA 'project'?

1.3 AIMS AND OBJECTIVES

In this research study, the aim was to investigate the nature and extent of the influence of the ANA tests on the Mathematics pedagogy in Grade 9 Mathematics classes.

The research therefore aimed to address the following objectives in an attempt to realize the over-arching aim, namely:

- To explore and describe to what extent the ANA has influenced the teaching of Mathematics in a Grade 9 Mathematics classroom.
- To examine the influence that ANA has on the learning of Mathematics in a Grade 9 Mathematics classroom.
- To explore if the ANA has an influence on assessment in a Grade 9 Mathematics classroom.
- To explore if the implementation of the ANA is aligned with the intention of the designers of the ANA 'project'.
- To formulate recommendations and future research possibilities.

1.4 RESEARCH METHODOLOGY

This section highlights the research design and the research approach with specific reference to the following elements of the research: research methods, population and sampling. A brief explanation is given of how the data were collected, analyzed, interpreted and triangulated.

1.4.1 Research paradigm

This study was approached from an interpretivist paradigm. Interpretivism centres on the meaning that individuals or communities ascribe to their experiences (Nieuwenhuis 2010:59). In this study, the aim was to develop an understanding of how the ANA

influences Mathematics in Grade 9. The problem under investigation lend itself to an interpretivist approach, since the focus was on obtaining the teachers' and learners' interpretations of the linkages between their teaching, learning and assessment and the ANA. From an interpretivist paradigm the researcher interacted closely with the participants (in this case the teachers and learners of Grade 9 Mathematics) to gain insight and form a clear understanding of their views and interpretation of the nature and extent to which the ANA influences their pedagogy and their view of how this translates into higher achievements in Mathematicsat this level.

1.4.2 Research methods

A qualitative research method was considered appropriate to execute this research, as the aim was to investigate to what extent the ANA influences teaching, learning and assessment in a Grade 9 Mathematics classroom. Three instruments were used to collect data to explore the pedagogical perspectives on the ANA tests in Grade 9 Mathematics, namely:

- Semi-structured interviews: In-depth interviews with a Mathematics teacher from each of the five sample schools were conducted through semi-structured interviews. Teachers were interviewed with respect to their practices around planning, teaching and assessment and how their teaching was affected by the ANA.
- Focus-group interviews: Grade 9 Mathematics learners in focus-groups, randomly assigned, were interviewed through semi-structured interviews. Interviews with the learners were conducted with regard to their belief of how the ANA test affected their learning process.
- Document analysis: The document analysis consisted of three parts: document analysis of the Diagnostic Report of Teacher D and the Diagnostic Report of the DBE of the ANA test written in September 2014; document analysis on the September 2014 test/examination of the sample schools and the ANA 2014 test and document analysis on the results of the ANA 2014 test and the results of the September 2014 test/examination of the five sample schools.

1.4.3 Population and sample

The research was conducted among teachers and learners of five secondary schools in Bloemfontein (six schools were originally selected to form part of the research, but one of the schools did not give permission to the researcher to conduct interviews). Therefore the sample consisted of five schools in the Motheo-district. The population of this study consisted of all schools teaching Grade 9 Mathematics in the General Education and Training (GET) phase in the Free State Province. The sampling decisions were made specifically for the explicit purpose of obtaining the best possible source of information to respond to the research questions. All educators (five) were selected on the basis that they were qualified to teach Mathematics and had at least one year of 'ANA experience'. Learners were purposefully selected from a merit academic list (two above average learners, three average learners and two below average learners).

1.5 DATA ANALYSIS

Data were analyzed according to qualitative data analysis principles. In other words, data were analyzed with the purpose of interpreting and understanding the perspectives presented by respondents (Walliman 2001:253). In this study, the data analysis was done on three sets of data. The first set consisted of the results from the Grade 9 teachers' semi-structured interviews. The second set consisted of the focus-group interviews with the Grade 9 Mathematics learners (five focus-group interviews). The third set consisted of the analysis of the Diagnostic Report of the ANA 2014 test compared to the Diagnostic Report of Teacher D; the analysis of the September 2014 Mathematics test/examination of the five sample schools and the ANA 2014 test and the analysis of the ANA 2014 results compared to the test/examination results of the sample schools.

Durrheim and Wassenaar (2002:64) referred to validity as the guarantee that the conclusions of the researcher stem from the data. The researcher strived to produce findings that are realistic and persuasive, in order to add to the credibility of the study. For the purpose of this study interpretative validity was used to ensure that results were

presented accurately and reflected the views presented by the respondents in the study. The researcher triangulated all data collected during the research process, including the interviews and document analysis to provide trustworthy findings. This ensured that there were not any inconsistencies in the findings.

1.6 ETHICAL ISSUES

The basic ethical norm was to protect the particular interest of especially exposed participants in the setting (Erickson 1982:141).

Before the actual process of collecting data could begin, the researcher had to obtain permission from the Free State Department of Education to undertake the research study. The letter of permission from the Free State Department of Education was attached to this research report as Appendix I. After permission for this study was obtained from the Free State Department of Education, the researcher informed the principals of the five sample schools about all aspects of the research study (see Appendix D). Teachers and learners gave informed consent to participate in the research study (see Appendix E and F). The participants were given the assurance that all data would be treated confidential and would only be used for academic purposes. The researcher ensured that the participants would not be exposed to any undue physical or psychological harm. Ethical clearance was obtained from the clearance office of the Faculty of Education (FoE) at the University of the Free State (UFS). The ethical clearance certificate, reference number UFS-EDU-2014-036, was attached as Appendix H.

1.7 DELIMINATION

The research study investigated the effect of the ANA on the Mathematics pedagogy in the Grade 9 classroom. The study also reflected specifically on the effect of the ANA tests on the teaching, learning and assessment of Grade 9 Mathematics.

This study was conducted within the discipline of Education, specifically Curriculum Studies, which is part of the discipline of Education. The focus of the study was on assessment and the influence of the ANA tests on the Mathematics pedagogy.

1.8 DEFINITION OF TERMS

Definitions and understanding of various types of knowledge and assessment are essential since the main goal of education is to enhance learners' understanding in learning. According to Edwards *et al.* (2007:443-465) belief systems are highly related to how individuals seek and structure knowledge. It seems very important to know how teachers' beliefs regarding the nature of Mathematical knowledge influence their decisions in classroom teaching.

The following concepts require to be defined, as they were used in this research.

1.8.1 Pedagogical Content Knowledge (PCK)

According to Shulman (1987:8) Content Knowledge is necessary but not sufficient for good teaching. Teaching of Mathematics therefore requires more than just Content Knowledge. Teachers need to recognize if an answer is correct or incorrect, analyze the source of the mistake and work through the mistake with the learner.

Shulman (1987:8) defined PCK as "the blending of content and pedagogy into an understanding of how particular topics, problems or issues are organized, represented and adapted to the diverse interests and abilities of learners, and presented for instruction". Other authors view PCK as an integration of generic pedagogical knowledge, Mathematical teaching methodology and knowledge of the discipline of Mathematics (Lim-Teo *et al.* 2007:237-261). In essence PCK includes an understanding of the cognitive, social and affective characteristics of a Mathematics classroom. Ball is in agreement with Shulman in her model (cf. 2.3.6) but refined two knowledge types namely Subject Matter Content Knowledge (SCK) and PCK.

1.8.2 Formative assessment

Formative assessment refers to assessment that is specifically intended to design feedback on performance in order to enhance learning. Formative assessment is used to support the teaching and learning processes, therefore assessment for learning is implemented. Formative assessment is the most commonly used type of assessment because it can be used in different forms at any time during a Mathematics lesson. For

example, short class work during or at the end of each lesson and verbal questioning during the lesson. Formative assessment is thus assessment for learning. It is mainly informal and should not be used for grading purposes. Formative assessment can be regarded as formative only if it leads to actions by teachers and/or learners that improve learning (Boston 2002:1; Carless 2005:44).

The vital distinguishing characteristic of formative assessment is constant feedback to learners' learning processes. Feedback from formative assessment can also be used by teachers to adapt and/or improve their teaching methods (Sadler 1989:145-165).

1.8.3 Summative assessment

In contrast to the character of formative assessment, summative assessment is carried out at the end of a lesson or a cluster of related topics in for example Mathematics. Since it focuses mainly on the product of learning, it is referred to as assessment of learning. The results of summative assessment are recorded and used for promotion purposes (Geyser 2004:93; McMillan 2011:161-162).

The distinction between formative and summative assessment was made explicit by Scriven. He preferred summative assessment, but was aware of the preference for formative assessment of his colleague Cronbach who viewed it as "part of the process of curriculum development" (Scriven 1967:41) (see Table 3.1).

Assessment is about making conclusions based on the quality of learners' performance. It can be used both to summarize learners' achievements in order to award some kind of certification (summative assessment) and/or to give feedback to students in order to support learning (formative assessment) (Falchikov 2005:3).

1.8.4 Implemented curriculum

Implemented curriculum is related to the learning process from the teacher's perspective. The teacher's interpretation of what the implemented curriculum implies as well as the instructional process in the classroom represent the implemented curriculum (Johansson 2005:120).

1.8.5 Hidden curriculum (implicit curriculum)

Diverging from the instructive curriculum, learners experience an 'unwritten curriculum' characterized by informality and lack of conscious planning. Jackson stated that learners' skills, beliefs and their attitude towards work are influenced by the degree to which they value successful competition. Negative effects and discipline problems may occur for learners who have difficulty following and assuming classroom rules and daily routines (Jackson 1992:3-40). The hidden curriculum can also promote learners' reluctance to oppose teachers' educational issues. Several inconsistencies regarding the nature and utility of the hidden curriculum in schools exist. One of these inconsistencies is that hidden curriculum is by nature more spontaneous and less clear than the regular curriculum (Miranda & Magsino 1990:170-173).

1.8.6 Curriculum and Assessment Policy Statement (CAPS)

The Curriculum and Assessment Policy Statement (CAPS) is a single, fully-inclusive, and brief policy document, which forms part of the National Curriculum Statement Grades R-12 (NCS Grades R-12) (DBE 2011:7). The NCS Grades R-12 is a policy statement for learning and teaching in South Africa. The CAPS addresses the gaps and challenges that were identified in the NCS. This facilitates the improved understanding of the curriculum focus and direction by teachers and resultantly improves classroom practice (DBE 2011:7).

CAPS forms part of the NCS for learning and teaching in South African schools and consists of the following:

- Curriculum and Assessment Policy Statements for all approved subjects.
- National policy relating to the programme and promotion requirements of the National Curriculum Statement Grades R-12.
- National Protocol for Assessment Grades R-12 (DBE 2011:7).

1.9 LAYOUT OF THE STUDY

Chapter 1 dealt with the exploration of the problem. In this chapter the problem pertaining to the study was discussed, and based on the problem statement and

research questions that were formulated. In other words, the aim of the study was stated and the objectives that will be pursued to reach this aim were indicated. This chapter also included the research methodology, data analysis and ethical issues of this research study.

In order to answer the first research question in 1.2, a literature study was undertaken in Chapter 2. The literature study investigated the cognitive learning theories of Piaget, Vygotsky, Kolb and De Corte, and also on the social and cognitive theories of knowledge of Durkheim, Bernstein, Bandura and Young because all these theories will impact on the executed pedagogy in a classroom. Chapter 2 also included the Pedagogical Content Knowledge views of Ball and Shulman.

The third research question in this research study is: Does the ANA have an influence on assessment in a Grade 9 Mathematics classroom? In order to answer this question a literature review on the views of assessment, the purpose of assessment, different types of assessment and the role that assessment plays in aligning teaching, learning and assessment was conducted in Chapter 3.

Chapter 4 describes the research methodology that was used to underpin the research. It also provides detailed processes that were carried out in order to generate the data required to answer the questions posed in this study.

Chapter 5 presents the analysis of data and the interpretation of research findings. This chapter concerns the actual collection of data required in answering the research questions.

Chapter 6 provides the findings, conclusions and recommendation of the research. This chapter also discusses the importance of the study and gives suggestions for further research.

1.10 SUMMARY

In this opening chapter the current problems in Mathematics education were highlighted. Emphasis was placed on highlighting the resultant low achievement levels of Grade 9 learners writing the ANA tests. It is thus necessary to investigate whether the

ANA tests have an influence on teaching, learning and assessment in a Grade 9 Mathematics classroom. Based on this, a problem statement and objectives were formulated to assist in the investigation of the problem stated. The research design that was used to investigate the questions raised by the problem was discussed and relevant terminology was explained.

The next chapter is a literature study on teaching and learning in education to determine from the existing literature how the ANA can positively or negatively contribute to teaching and learning in a Grade 9 Mathematics classroom.

CHAPTER 2

TEACHING AND LEARNING

IN A MATHEMATICS CLASSROOM

Education is an admirable thing, but it is well to remember from time to time that nothing that is worth learning can be taught.

Oscar Wilde

2.1 INTRODUCTION

The aims for examining the nature and extent of the influence of the ANA tests on the Mathematics pedagogy in a Grade 9 Mathematics classroom were described in Chapter 1. Two of the objectives of this study were to explore and describe to what extent the ANA has influenced the teaching and learning of Mathematics in a Grade 9 classroom. To have a better understanding of the impact of the ANA on the teaching and learning of Mathematics, an understanding of the teaching and learning of Mathematics need to be reached.

Firstly the focus is on learning. The cognitive learning theories of Piaget, Vygotsky, Kolb and De Corte, and the social and cognitive theories of knowledge of Durkheim, Bernstein, Bandura and Young and how it has influenced pedagogy, and more specifically the pedagogy of Mathematics, will be discussed. Within the context of Education, it is important to also engage with the Pedagogical Content Knowledge views of Ball and Shulman. These theorists are all relevant to this study because of the acknowledgement that they have largely been involved with the issue of learning and knowledge in Education. Concerns about the quality of teaching and learning in a Grade 9 Mathematics classroom were raised therefore this chapter focuses on the quality of teaching and learning.

Secondly the focus is on three teaching approaches, namely the Executive, the Facilitative and the Liberationist approaches to teaching. These approaches are not static. Teachers can adjust their approach to teaching depending on external forces, such as unrealistic top down requirements of projects, which teachers are required to participate in. It is thus important to take cognisance of these teaching approaches and how these approaches affect the teaching, learning and assessment in a Mathematics classroom.

2.2 LEARNING

Teachers' personal assumptions of learning have long been observed as having substantial influence on almost all aspects of teachers' decisions about instruction. The expectations of what learning outcomes are, how one plans (for example organize structures and arrangement) and instruction is directly impacted by one's beliefs about learning. In addition, teachers' views of learning guide them as they make decisions about required means of implementing and assessing instruction (Wilson & Peterson 2006:1-4).

There is limitless literature on learning in schools and many definitions of learning. Pritchard (2009:2) includes the following as good examples of definitions of learning:

- Learning is a change in behaviour as a result of experience or practice.
- Learning is knowledge achieved through study.
- Learning is gaining knowledge of, or skill in, something through study, teaching, instruction or experience.
- Learning is the process of constructing and understanding based on experience from a wide range of sources.

Franzsen (1997:102), James (2006:49) and Vandeyar and Killen (2006:32) confirmed that teachers' views on how learning occurs and how knowledge is acquired influences the way in which they see their roles as teachers and educators. From this it can be assumed that if teachers took theories about the gaining of knowledge in cognisance,

they would achieve insight that would encourage them to question the significance of their own ideas about teaching and learning (Franzsen 1997:103).

Parkay and Hass (2000:165) distinguished between cognitive and behavioural learning theories. They argue that both these sets of learning theories influence teaching practices. It is therefore necessary to study both cognitive and behavioural theories.

The following sections focus on the learning theories of Piaget, Vygotsky, Kolb and de Corte.

2.2.1 Piaget's Cognitive Development

Piaget's (1896-1980) work was based on a variety of concepts which were aimed at revealing his views on the way in which children developed cognitively (Borich & Tombari 1997:39, Child 2004:64, Eggan & Kauchak 1999:27, Woolfolk 2004:30-31). Van Harmelen and Bolt (2000:35) described Piaget as the pioneer of cognitive psychology as it was he (Piaget) who started the idea that knowledge is constructed in the mind. According to Cawelti (2003:20) Piaget's work awakened the acknowledgment that children construct knowledge through the ways in which they adapt to their environment. Lefrancois (2000:227) agreed that Piaget's acquisition of knowledge is an ongoing developmental process made possible through the interaction of the child and the environment.

Through his research, Piaget identified the following four stages of cognitive development in children namely the:

- Sensory motor stage – age 0 to 2 years.
- Pre-operational stage – age 2 to 7 years.
- Concrete operational stage – age 7 to 11 years.
- Formal operational stage – age 11 years onwards.

Piaget acknowledged that some children may pass through the stages at different ages than the average noted above and that some may show characteristics of more than one stage at a given time. He continued that cognitive development always follows this order, stages cannot be skipped and that each stage is marked by new intellect abilities

and a more complicated understanding of the world (Child 2004:69; Elliot *et al*. 1996:8; Mwamwenda 1996:89).

The last two stages, namely the concrete operational and the formal operational stage (Bell 1980:67), are important to teachers teaching the Senior Phase (Grade 7 to 9) since it is assumed that learners are usually in one of these stages or in the transitional period between the two stages when they are in the Senior Phase.

Piaget viewed cognitive growth as a process of adaptation (alteration) to the world and this happens through the processes of assimilation and accommodation. Assimilation is described as the way in which new structures relates to existing structures. Piaget's work demonstrates that any given level of knowledge is a result of the reorganisation of the previous level. Should existing knowledge be incorrectly organized, learners will find it impossible to understand new information (Kruger 1997:232). Accommodation happens when the existing knowledge does not work, and needs to be adjusted to deal with a new situation (Eller & Henson 1999:44). This leads to the importance of determining at which stage the learners are before presenting new information. It is also important to fully address whether learners are capable of understanding the new material based on their current developmental stage. Understanding how learners move through this developmental process can enhance our understanding of how learners learn and therefore, increase the prospects of understanding new complex ideas.

It is evident that the ANA can distort the process of assimilation if teachers do not engage with previous levels of knowledge of their learners. It is thus important that teachers need to establish the level of knowledge of the learners before dealing with a new situation. The way in which the ANA is engaged in the teaching and learning situation can thus have a positive or negative impact on the cognitive development of the learner seen from a perspective of the theory of Piaget.

2.2.2 Vygotsky's theory on learning

Vygotsky (1896-1934) presented an alternative view of cognitive development to Piaget's view. Piaget maintained that cognitive development results from the child's ability to use adaptation (assimilation) and organisation (accommodation) in creating

new knowledge. According to Piaget's approach the child is constructing new knowledge in his/her mind supported by what is already known. Vygotsky, on the other hand, believed that language plays an important role in the social and cultural interaction in human development. He did not perceive the child as a solitary pioneer of knowledge, but that he/she as a learner engages in social interactions that involve communication. As a result Vygotsky emphasized the role of language development in the teaching learning process. Similar to Piaget, Vygotsky viewed children as working partners in their own learning process (Rieber & Wollock 1997:63-79).

Vygotsky (Rieber & Wollock 1997:63-79) stated that social learning precedes development. He stated that "every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level. Firstly between people (inter-psychological) and then inside the child (intra-psychological)". Vygotsky saw an important role for teachers/adults in extending children's learning beyond areas in which they are independently capable. He used the term "Zone of Proximal Development" (ZPD) to describe the extension of skills a child is capable of with adult help. Shabani *et al.* (2010:237-248) define the ZPD as the distance between a learner's ability to perform a task under adult guidance and/or with peer cooperation and the learner's ability to solve the problem independently. It can therefore be seen as the difference between what a child can do on his own and what can be done with help.

Both Piaget and Vygotsky provided education with important views on cognitive development in the child. Piaget proposed that children progress through stages of cognitive development and some social transmissions through assimilation and accommodation, while Vygotsky viewed language and ZPD as important (Shabani *et al.* 2010:237-248).

In a Mathematics classroom, teachers need to design lessons that empower learners to "make meaning through mindful manipulation of input" (Fogarty 1999:78). By successfully incorporating Vygotsky's theory into the classroom the ANA can have a positive impact on learners' achievement.

2.2.3 Kolb's experiential learning

As the above learning theories turn toward cognitive and social perspectives, educational psychologists became interested in how learners think, learn concepts and solve problems (Ausubel 1960:267-272; Bruner, Goodnow & Austin 1956:81). Kolb (1984:21) assumed that learning takes place through experience. Kolb's Experiential Learning Theory (Kolb 1984:41) defines experiential learning as "the process whereby knowledge is created through the transformation of experience".

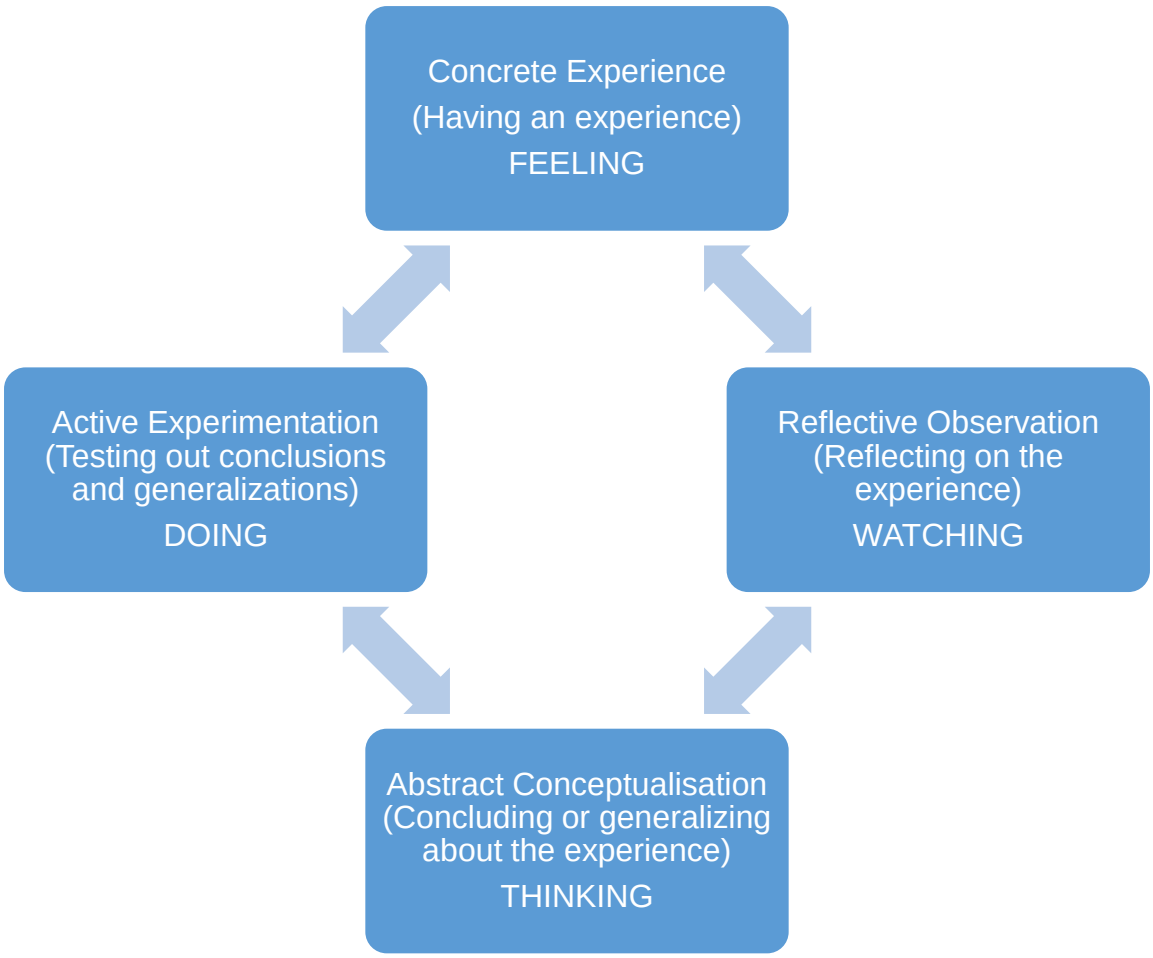

Figure 2 1: Kolb's experiential learning cycle

Kolb (1984:41)

Kolb described the four stages in the cycle of experiential learning as:

- Concrete experience where the learner relies on beliefs and reaction to experience.
- Reflective observation where the learner relies on his/her own beliefs and feelings in forming opinions through listening.
- Abstract conceptualization where the learner learns from theories and logic concepts.
- Active experimentations where the learner learns in active form thus experimenting with changing situations.

The cycle begins with learning from feelings or reactions to experience (Stage 1) where a problem is posed or an action is performed. In Stage 2 the learner learns from watching and listening by understanding the concepts. In Stage 3 the learners may conceptualize and in Stage 4 the learners draw conclusions about what they have experienced and observed, leading to learning by doing. This learning cycle involves both concrete components (Stage 1 and 4) and conceptual components (Stage 2 and 3). According to Kolb these stages require a variety of cognitive and affective behaviours (Kolb 1984:41).

Preparing learners' tests, such as the ANA, can easily result in learners not being exposed to the four steps in Kolb's learning cycle depending on whether teachers teach according to the test. It is though expected that learners would have been exposed to a certain extent of Kolb's steps before taking a test.

2.2.4 De Corte's view on learning

De Corte and Weinert (1996:35-38) defined learning as a process of meaning making and knowledge building and where the learning process has characteristics such as:

- Construction of own knowledge: Learning is an effortful and mindful process in which learners actively construct their knowledge and skills through the reorganizing of already acquired intellectual structures in interaction with the natural world.

- Cumulative: This characteristic emphasizes the importance of the impact of learners' prior formal as well as informal knowledge on later learning.
- Self-regulated: This is the meta-cognitive nature of productive learning; indeed self-regulation of learning means that learners manage and observe their own processes of knowledge building on skill achievement.
- Goal oriented: Effective and significant learning is facilitated by a clear awareness of, and direction towards a goal.
- Situated and collaborative: This characteristic of learning is conceived as an interactive activity between the individual and the physical, social and cultural context and artefacts', and especially through participation in cultural activities and context.
- Individually different: Prior knowledge, conceptions of learning, learning styles and strategies can affect the process and outcomes of learning.

According to De Corte and Weinert (1996:38) the concept of learning as an active constructive, self-regulated process does not imply that learners' construction of their knowledge and skills cannot and should not be guided through appropriate coaching, feedback and examples by their teachers. Mayer (2004:14-19) concluded that guided discovery learning lends to better learning outcomes than direct instruction. A powerful innovative learning environment is characterized by an effective balance between discovery and personal exploration, and systematic instruction and guidance.

2.3 KNOWLEDGE

The aim of this research is to investigate the nature and extent of the influence of the ANA on the Mathematics pedagogy in Grade 9 Mathematics classrooms. Embedded in this aim is the need to question the concept knowledge and how learners gain knowledge.

The word 'knowledge' is explained in the Oxford Dictionary as 'facts, information, and skills acquired through experience or education' (Oxford Dictionary 2007).

Constructivism is knowledge gaining, highlighting the construction of knowledge. The role of the learner is described as one of building and transforming knowledge. According to Moshman (1982:371-384) there are different notions of the nature of knowledge and the knowledge construction process. Liu and Matthews (2005:387) revealed that there are two important variants of constructivism namely cognitive (radical) constructivism and social (realist) constructivism. Radical constructivism is mostly in agreement with Piaget's work. According to Piaget knowledge is individually constructed or discovered (Liu & Matthews 2005:386-399). Social constructivists place the social environment at the centre of learning and it is seen as being situated specific and context bound (Liu & Matthews 2005:388). According to De Corte and Weinert (1996:xxv) social constructivism can be described as the process through which learners construct knowledge in the presence of other learners and teachers where interaction occurs. Thus, constructivism implies that knowledge should be integrated into existing internal structures as suggested by Piaget (cf. 2.2.1) and Vygotsky (cf. 2.2.2) (Troutman & Lichtenberg 1995:25).

The following discussion focuses on the social and cognitive theories of Durkheim, Bandura, Bernstein and Young with interplay between behaviourism and constructivism.

2.3.1 Durkheim's contribution to the sociology of knowledge

The sociology of knowledge was pioneered primarily by the sociologist Emile Durkheim (1858-1917) at the end of the 19th and beginning of the 20th century. His work dealt directly with how conceptual thought, language, and logic could be influenced by the social environment in pedagogy (Goldstein 1976:289-297).

Durkheim proposed the transmission (of knowledge) through the teacher to the learner. The assimilation of a subject by the child is the condition of real intellectual formation. Thus, knowledge formation is essentially social and is learned as explained below. In the light of this, the issues of the structure and content of knowledge must lie at the heart of a sociological understanding of curriculum development. Durkheim stated that the basis of his social theory of knowledge is the fundamental sociality of human beings; everything that is human is social. According to Durkheim the generality of the world for

its members is situated in the objectivity and simplification of knowledge. Durkheim further implied that we might create a social theory by looking at the differences between the analytical and the descriptive, between the theoretical and the everyday and also between what is necessary and what is trustworthy (Emirbayer 1996:263-281). His theory of knowledge is also the basis for a theory of curriculum development; it entails a set of origins for the selection of Curriculum Knowledge. As a result, his theory presented sociology of the knowledge and truth, and a theory of the basic differentiation of the base of knowledge (Young 2008:68).

Durkheim's ideas were based on studies of primitive societies (Goldstein 1976:289-297). In the everyday society that he studied his starting point was the profane and sacred orders of meaning. The profane refers to people's reaction to their everyday world. Thus, this refers to the practical, direct aspects of social life. The sacred was seen as a shared product of a society and not connected directly to any real world experience. According to Durkheim the sacred became the paradigm for other kinds of conceptual knowledge including the Science, Philosophy and Mathematics. Durkheim was equally separated from the everyday world. Durkheim argued that both aspects of knowledge, the sacred and the profane, are frequently ignored in general education and even vocational curricula. It follows that Durkheim's analysis specified an explanation for the problems of the standards-based approach of knowledge that downplays the distinction between the sacred and the profane and inescapably prevents learners from opportunities to either generalize or visualize alternatives (Young 2008:146). Factors to take into account in the education process are the class environment, the school environment and the teachers'/learners' attitudes.

According to Durkheim, truth and knowledge have a givenness that is historical and social. Durkheim argued that we make knowledge, just as we make institutions, in relation to our history and on the basis of what former generations have noticed or established. Perhaps unexpectedly for someone so concerned with consent, it is Durkheim, rather than the pragmatists with their obsession with problem solving, who by understanding the pressure between knowledge as a social given and this givenness

being historically formed, provides the basis for a social theory of improvement (Muller 2000:173).

When related to social constructivism, Durkheim's insight underlined the limits that the social (for him, society) imposes our ability to socially construct reality. It is those limits (the boundaries as Bernstein would put it [cf. 2.3.3]) that allow us to search for the truth. Assuring a need or link to an interest is ultimately subjective criteria and can never be acceptable as criteria of truth. Sometimes the truth does exactly the opposite in satisfying a need and does not seem to be in one's interest; however, that does not stop it from being true. According to Durkheim, the social is the moral: it is about values. It is about values, therefore it is mainly a moral issue. Moore and Young (2001:4) questioned Durkheim's association of the social with the moral when addressing the question of knowledge. They were rather of the opinion that a cognitive as well as a moral concept of the social is crucial to develop an alternative to social constructivist sociology of knowledge (Moore & Young 2001:445-461; Schmaus 1994: 89-110). Durkheim's social theory of knowledge created important implications for learning. It is clear from the above that Durkheim's theory of sociology plays an important role in education and it can briefly be summarized as follows:

- The class, school and attitudes of teachers/learners are factors to be taken into account in the education process.
- For effective learning to take place, teachers have to create an environment that will be sufficiently powerful to ensure effective learning.
- Each learner must be evaluated according to his/her own performance.
- Not disclosing knowledge in pedagogy is a social moral issue.

These implications have an impact on the learning and teaching of Mathematics in a Grade 9 classroom. Durkheim's work on the social relations and the relations of individuals in society can help the teacher and learner to mediate on the importance of the teacher/learner relationship and the concept of knowledge.

2.3.2 Bandura's approach to learning

Bandura's theory gives value to both the environment and the intellectual aspect of the human being. As a result, it has often been called a link between behaviourist and cognitive learning theories (Bandura 1971:1-4).

Learners are constantly surrounded by social influences, whether it is a community influence or a media influence. According to Bandura (2008:96) humans have developed an advanced capacity for observational learning that enables them to expand their knowledge and skills. Allport (1985:3) assumed that observing behaviours effects one's own actions and is typical of social learning. Brophy and Good (1995:158-159) strengthened this view, as they argued that learners learn from one another. In a Mathematics class a typical behaviourist lesson will start with a teacher showing the learners a concept. This will be followed by learners continuing to practice the concept on similar problems, applying the drill and practice method (Maree 2004:245; Sanni 2007:40; Schifter 2007:23). Through this method the teacher encourages the learner by memorising the concept, but this method does not necessarily help to understand the concept. In a Mathematics classroom, learners that are taught from a behaviourist perspective battle to solve problems as they are not used to have practiced solving it yet. The moment when a teacher assesses a learner with a problem formulated outside the normal pattern, learners struggle to apply the rule for the problem. In the view of the world, behaviourism assumes that a learner is essentially passive and responds to the environment. The centre of learning for the social constructivist is the social environment. The constructivist on the other hand sees the social environment as the centre of learning (Liu & Matthews 2005:388).

The behaviourist's view generally assumes that the outcome of learning is a change in behaviour, and emphasizes the effects of external events on the individual. The response leads to a result and when the result is pleasant, the behaviour change is reinforced. Pritchard (2005:15) confirmed that with consistent reinforcement, the behaviour pattern becomes conditioned. According to Woolfolk (2007:300), behaviourism in school acknowledges that each person has different characteristics, abilities and challenges that result from learning and development. These differences

are apparent in each individual as far as intelligence, creativity, cognition, motivation and the capacity to communicate and interact with those around them. Woolfolk (2007:300) asserted that behaviourism in school can be seen that learners retain the knowledge and skills they learned in school and can apply these in real-world situations beyond the classroom. In a behaviourist paradigm typical assessment involves formal teacher-directed, standardized tests, identifying deficits in learning and ranking learners, such as the ANA. These tests do not do more than to test memory and rote learning and do not necessarily involve understanding (Vandeyar & Killen 2006:32).

According to Steyn and Wilkinson (1998:206) behaviourism can be considered as an approach which emphasizes the product of learning, the desire for learners to achieve certain learning behaviours and performs specific actions. Social constructivism is more concerned with the process of learning and the aim is to assist learners to construct not merely their own meanings, but also knowledge, attitudes and abilities (Steyn & Wilkinson 1998:206) without losing sight of the product. This is also the view of Schunk (1996:12) who assumed that learners construct what they learn and their understanding is based upon previous learning and social interaction.

Teachers are usually neither constructivists nor behaviourists, but find themselves somewhere between the two learning theories (Du Toit *et al*. 2000:17). James (2006:48) noted that in reality it is possible for teachers to combine behaviours associated with both behaviourism and constructivism in the teaching-learning situation.

Due to the hierarchal structure of Mathematics learners struggle to understand new work if pre-knowledge is not present. Based on what learners already know, they will actively process new information. Van de Walle, Karp and Bay-Williams (2010:23) assumed that understanding can be described as a measure of the quality and quantity of connections that an idea has with existing ideas. When learners build new knowledge, their knowledge must be built on some foundation. In the lower grades the knowledge and skills serve as building blocks for the higher grades (Spinelli 2002:376).

As was mentioned earlier (cf. 2.2) that there is a social and cognitive approach to knowledge and the following theory of Bernstein argued that social interaction plays a fundamental role in the development of cognition.

2.3.3 Bernstein's horizontal and vertical discourse

The issue of differentiation, a crucial aspect of the sociological understanding of curriculum development, was pertinently addressed by the English sociologist Basil Bernstein (1924-2000).

Bernstein was one of the most influential and widely studied theorists in the sociology of knowledge (Singh 2002:571-582). His publications started in 1958 and continued until 2000. He is among the greatest theorists in the field of the sociology of education, showing a particular concern for education. According to Morais and Neves (2001:1-12) Bernstein's ideas have measured the change that has taken place in the education system.

Bernstein took Durkheim's ideas of knowledge differentiation further in a number of important ways.

Bernstein saw Durkheim's idea of boundaries as the key social category separating types of symbolic meanings further by referring to the concepts of classification and framing. Bernstein used the idea of classification and framing to show how boundaries in pedagogy play a major role in the growth of learner and teacher identities (Bernstein 1971:205-214).

Bernstein succeeded in making trustworthy links to other areas of knowledge such as curriculum and pedagogy. His distinctive insight was to emphasize the key role of knowledge boundaries, both as a condition for the gaining of knowledge and as embodying the power relations that are necessarily involved in pedagogy (Christie 1999:156-184). Bernstein conceptualized boundaries in terms of two dimensions. Firstly the classification of knowledge between domains (the framing of knowledge) and the degree of insulation between school knowledge of the curriculum and the everyday knowledge that a learner brings to the classroom. Secondly the classification of

knowledge can be strong (when domains are highly insulated from each other) or weak (when there are low levels of insulation between domains) (Bernstein1971:205-214). Likewise, framing (Hoadley 2012:95) can be strong when school and non-school knowledge are insulated from each other; or weak when the boundaries between school and non-school knowledge are blurred.

In his later work, Bernstein moved from a focus on relations between domains to the structure of the domains themselves by introducing a distinction between vertical and horizontal knowledge structures. Vertical discourse consists of academic knowledge (horizontal knowledge structures and hierarchical knowledge structures). Horizontal discourse consists of the knowledge developed through practice (everyday practice and complex practice). According to Bernstein "verticality in horizontal knowledge structures occurs not through integration but through the introduction of a new set of concepts which constructs a fresh perspective, a new set of questions, a new set of connections, and apparently new problems, and most importantly a new set of speakers" (Bernstein 2000:162). Moss (2001:155-156) explained that the form of knowledge in school settings is always sequentially ordered. What is known now gains its significance from what comes next, as well as what has gone before. Thus in this sense knowledge performed at a particular moment in school is never independent, but always points both forward and back, creating good progress.

It is clear from the foregoing discussions that Bernstein's theory plays an important role in education and more specifically in pedagogy, as indicated in the summary below:

- Learners need to be taught in a manner that will enable them to transfer knowledge from the classroom to the environment.
- Learning should always start from a learner's current understanding. Thus the identification of prior knowledge and understanding is essential.
- The social element of knowledge namely discussion and interaction, can be effective if it takes place between learner and learner as well as between learner and teacher.
- The contextualization of teaching should be explored as far as possible.

The following theory of Young shows the links that he made on the theoretical and practical in pedagogy.

2.3.4 Young's view of knowledge

Young emphasized the terms Knowledge of the Powerful and Powerful Knowledge. He referred to Knowledge of the Powerful as the knowledge authorized by those in power and this leads to questions about who has the power and whether knowledge is adequate and on what basis (Young 2012:142-147). Therefore Knowledge of the Powerful refers to who defines what counts as knowledge and has access to it.

According to Young the concept Powerful Knowledge (conceptualizing the curriculum) is the knowledge itself, its structure, what it can do and how it is classified for both the construction of new knowledge and achievement of existing knowledge which is new to the learner. A working definition of Powerful Knowledge focuses on its purposes and the conditions for its production and access. According to Young and Muller (2010:11-27) Powerful Knowledge:

- Presents trustworthy and in general sense 'testable' details of ways of thinking.
- Forms a basis for suggesting realistic alternatives.
- Supports those who acquire knowledge, to see beyond their everyday experience.
- Is theoretical as well as based on evidence and experience.
- Is always open to question.

Young emphasized the significant overlap between Powerful Knowledge and the Knowledge of the Powerful. Powerful Knowledge rests upon the distinction between two types of concepts namely the theoretical and the everyday or common sense. He continues that it is everyday concepts which constitute the experience that learners bring to school. On the other hand, it is the theoretical concepts associated with different subjects that the curriculum can give access to. Acquiring Powerful Knowledge is learning to use these theoretical concepts. Young attached Powerful Knowledge to discrete school subjects. Young favoured a curriculum based on academic subjects because that provides Powerful Knowledge (Young 2012:142-147). The key curriculum

question will be concerned with how specialist knowledge is pedagogized. In other words, how it is paced, selected and sequenced in for example for learners in their Grade 9 year doing the ANA tests in September 2014. The question can be asked whether the learners in Grade 9 are exposed to Powerful Knowledge or whether they are exposed to the knowledge of those in power. A follow up question to be asked is whether Powerful Knowledge is the knowledge of those in power?

From the discussion above it is evident that Young's Powerful Knowledge plays an important role in pedagogy and it can briefly be summarized as follows:

- Knowledge is worthwhile in itself and learners therefore need to know that they never need to apologize for things that they need to learn.
- Schools transfer Powerful Knowledge so that learners can make sense and improve the world.
- Children need Powerful Knowledge to understand and interpret the world otherwise they remain reliant on those who have knowledge.
- Powerful Knowledge is cognitively superior to knowledge needed for daily life and it will therefore excel and release children from their daily experiences.
- Powerful Knowledge enables children to grow into valuable citizens so that when they are adults can understand, help and shape the world together.

2.3.5 Shulman's theory on Pedagogical Content Knowledge

In his 1968 presidential address delivered to the American Educational Research Association Membership, Shulman suggested three categories of teacher subject-matter knowledge. The aim of his first category namely Content Knowledge, was to indicate "the amount and organization of knowledge…in the mind of teachers" (Shulman 1987:1-21). According to Shulman, Content Knowledge includes both facts and ideas in a domain, but also why facts and ideas are true and how knowledge is constructed and planned in the discipline (Hill, Rowan & Ball 2005:376).

Shulman differentiated among three categories of Content Knowledge: Subject matter Content Knowledge (SCK); Pedagogical Content Knowledge (PCK); and Curricular Knowledge (CK) (Shulman 1986:9).

SCK describes the amount and arrangement of knowledge in the mind of the teacher. SCK expects going beyond knowledge of the factual of views of a domain. It requires understanding of the structures of the subject matter in the manner defined by Schwab (1978:229-272). This according to Young (cf. 2.3.4) is Powerful Knowledge with a vertical knowledge structure as stated by Bernstein (cf. 2.3.3). Teachers must not only be able to define the accepted truths in a domain to learners, but they must also be able to justify why a particular intention is considered justified, why it is worth knowing, and how it relates to other proposals, both within the discipline and without, both in theory and in practice. According to Shulman (1986:9): “The teacher need not only understand that something is so, the teacher must further understand why it is so”, and this implies that teachers’ SCK should represent a deep understanding of the material to be mastered by the learners. SCK is a significant aspect of teaching since it affects planning, task setting, questioning, explaining, giving feedback and assessment in the ANA test.

PCK goes beyond knowledge of subject matter as such to the dimension of subject matter knowledge for teaching. Here Shulman referred to Content Knowledge, but further to the specific form of Content Knowledge that embodies the aspects of content. PCK is an example of a horizontal knowledge structure as supported by Bernstein (cf. 2.3.3). In the category of PCK Shulman included the topics taught in one’s subject area, the illustration thereof, the similarities, figures, examples, explanations, and demonstrations. In other words the way the subject is prepared to make it easier for learners to understand. PCK includes awareness of the cognitive, social and affective characteristics in a Mathematics classroom. It also includes understanding of learners’ cognitive development and the common Mathematical concepts. PCK also includes an awareness of what makes the learning of specific areas easy or difficult. The impressions and notions that learners of different ages and backgrounds bring with them in the learning of those most often taught areas and lessons. If those notions are misleading, which they so often are, teachers need knowledge to be successful in changing the understanding of learners, because those learners are not likely to appear before them as blank slates (Shulman 1986:10). Learners come to school with knowledge which Young (cf. 2.3.4) referred to as everyday knowledge.

Research has acknowledged several aspects that are specifically important to successful Mathematics instruction, and that might therefore be used to conceptualize Pedagogical Content Knowledge in a Mathematics-specific approach. Tasks play a dominant role in Mathematics instruction. Christiansen and Walther (1986:243-307) argued that classroom tasks are the medium through which teachers and learners communicate, and that the type of task influences the nature of learning. Appropriately selected and implemented Mathematical tasks lay the foundation for learners' construction of knowledge and represent powerful learning opportunities (de Corte *et al.* 1996:491-549; Williams 2002:66). Knowledge about the potential of Mathematical tasks for learning is thus a first important aspect of Mathematical Content Knowledge. Secondly, teachers need to work with learners' current conceptions and prior knowledge. Because errors and mistakes can cause valuable insights to hidden knowledge of the problem solver (Matz 1982:25-50), it is important for teachers to be aware of typical learner fallacies and comprehension difficulties. Learners' construction of knowledge often only succeeds with instructional assistance and advice (Mayer 2004:14-19), (cf. ZPD of Vygotsky in 2.2.2) which may entail various forms of explanations or the explicit use of representations. The knowledge of appropriate Mathematics-specific instructional methods is thus a third important component of Mathematical Pedagogical Content Knowledge. Whereas the latter two components are based directly on Shulman's (1986:4-14) generic conceptualization.

The domain-specific conceptualization of teachers' Content Knowledge seems straightforward. Clearly, teacher knowledge should go beyond a consciousness of the material to be mastered by the learner. Rather, teachers should possess Mathematical background knowledge of the content enclosed in the school curriculum at a much deeper level of understanding than their learners. This background knowledge of school curriculum content forms a knowledge base that is specific to teachers, in that it connects only partially with Mathematics typically taught at universities (Krauss, Brunner & Kunter 2008:717).

The third category of knowledge referred to by Shulman is CK which contains understanding of how topics are arranged both within a school year and over time and

ways of using curriculum resources, such as textbooks, to organize a program of study for learners (Shulman 1986:10). Here it is expected of a professional Mathematics teacher to be familiar with the curriculum materials, especially in the framework of this study on the CAPS curriculum on which the learners are tested in the ANA.

According to Shulman Mathematical facts, procedures, concepts as well as how knowledge is generated and structured are important in education (Shulman 1986:9). Summarizing his theory emphasizes the following.

- Subject Content Knowledge (SCK):
  - Is an in-depth understanding of the structures of the subject matter.
- Pedagogical Content Knowledge (PCK):
  - Is a significant aspect of teaching since it affects planning, task setting, questioning, explaining and assessment.
  - Includes awareness of the cognitive, social and affective characteristics of a Mathematics classroom.
  - Means the teacher must understand the learners' cognitive development in particular the concepts and definitions learners have with Mathematics.
- Curriculum Knowledge (CK):
  - A teacher must be familiar with the curriculum materials studied by his/her learners.

Ball built upon Schulman's theory of PCK. The following section shows Ball's theory of Content Knowledge for teaching.

2.3.6 Ball's theory of knowledge for teaching

Teachers' personal theories of learning have long been viewed as having considerable influence on virtually all aspects of teachers' decisions about instruction. Not only does one's expectations of what learning outcomes are, need to be valued and sought, but also how one plans (organizes, structures and sequences) instructions is directly impacted by one's belief about learning and how learners are assessed. In addition, teachers' views of learning guide them as they make decisions about desirable means of implementing and assessing instruction (Ball & Bass 2003:3-14). Gage (1977:15)

assumed that teachers use judgment, sudden insight, sensitivity and agility to promote learning. The processing of cognitive information is concerned with teachers' judgement, decision making and planning. How teachers gather, organize, interpret and evaluate information leads to the understanding of the process that guides and determines learners' behaviour.

Ball and Forzani (2010:8-12) assumed that, besides knowledge and skills, there also needs to be fluency in knowing Mathematics for teaching. Such fluency (coherence) may be found in an understanding of the developing mind of the child, coupled with what Mathematics, as a cultural phenomenon, has to offer learners.

Teachers' Mathematical knowledge is still a significant factor in their learners' achievement. Ball *et al.* (2005:14-46) proposed a framework that describes the knowledge associated with Mathematics for teaching. The framework consists of four 'distinct' domains, namely:

- Common Content Knowledge - the Mathematical knowledge of school curriculum.
- Specialized Content Knowledge - the Mathematical knowledge that teachers use in teaching that goes beyond the Mathematics of the curriculum itself.
- Knowledge of Content and Students - the intersection of knowledge about learners and knowledge about Mathematics.
- Knowledge of Content and Teaching - intersection of knowledge about teaching and knowledge about Mathematics (Ball *et al*. 2005:14-46).

<table>
<tr><th colspan="2">Subject Matter Knowledge</th><th colspan="2">Pedagogical Content Knowledge</th></tr>
<tr><td>COMMON CONTENT KNOWLEDGE</td><td rowspan="2">SPECIALIZED CONTENT KNOWLEDGE</td><td>KNOWLEDGE OF CONTENT AND STUDENTS</td><td rowspan="2">KNOWLEDGE OF CURRICULUM</td></tr>
<tr><td>KNOWLEDGE AT THE MATHEMATICAL HORIZON</td><td>KNOWLEDGE OF CONTENT AND TEACHING</td></tr>
</table>

Figure 2.2: Ball's model of Subject Matter Knowledge and Pedagogical Content Knowledge

Hill *et al.* (2008:377)

Figure 2.2 illustrates a proposed model of Mathematical knowledge for teaching and can be used to demonstrate how teachers' Mathematical knowledge relates to both Subject Matter Knowledge and Pedagogical Content Knowledge. Ball included all knowledge types of Shulman in her model, but refined it to two knowledge types, namely SCK and PCK. She expanded SCK to include in depth knowledge of school Mathematics and saw CK as part of PCK. Each of the six portions of the squares is a proposed strand of Mathematical knowledge for teaching. The left side of the square, labelled Subject Matter Knowledge, constrains two strands namely common Content Knowledge and specialized Content Knowledge. The right side of the square represents strands namely Knowledge of Content and students and Knowledge of the Curriculum.

Good teachers know both content and how to get it across to their learners. Research (Ball & Lampert 1998:26) agree that an understanding of content matters for teaching. Content Knowledge for teaching is a practice-based theory that describes the Content Knowledge involved in the teaching of Mathematics. Teaching occurs indirectly through

face-to-face interactions with learners. Teaching involves analyzing learners' work and assessing learners. Ball argued that research on Secondary school teachers' teaching and its progress moved teachers' knowledge of subject matter to the centre stage. The concept of Content Knowledge, linked with the understanding of learning and learners, is explained as the kind of knowledge content that teachers obtained and needed. The concept of Pedagogical Content Knowledge or Knowledge of the best and most useful arguments of what topics students are likely to be fascinated with and of the kinds of difficulties learners are likely to have with specific academic theories and practices draw attention to the special ways in which teachers need to understand content (Ball & Lampert 1998:26).

Teachers help learners to investigate the original meanings of Mathematics. They have to evolve their classes in conversations on difficulties and facts, discussions and knowledge, rather than merely underlining performance. This kind of teaching opposes challenges by exposing the classroom communication as well as the ways in which knowledge is handled and by insisting on a finer and more continuing judgment of learners' knowledge (Ball *et al.* 2005:14-46).

It is obvious that Ball's theory had a big impact on education. Her theory can be summarized as follows:

- Knowing Mathematics means knowing how to do it.
- Teachers cannot explain a certain principle to his/her learners if he/she does not understand it himself/herself.
- Teachers need to know the content they teach and what learners are expected to master.
- Teachers who understand the content of Mathematics can be more flexible in delivering knowledge. They are also more capable to break big concepts into smaller connected pieces to ensure that learners learn and understand.

The planning of lessons, evaluation and assessment involve knowledge of Mathematical ideas as well as skills in Mathematical reasoning. In teaching, teachers' understandings and beliefs about Mathematics interact with their ideas about the

teaching and learning of Mathematics as well as their ideas about learners, teachers, and the context of classrooms.

This section engaged with the concept knowledge. First a broader view of knowledge and more specifically whose knowledge were discussed where after knowledge needed by teachers to teach a specific subject, such as Mathematics, were questioned. In the next session different teaching approaches will be discussed.

2.4 TEACHING

Teaching is helping other people to learn, through obtaining knowledge they need. Teaching involves guiding learners in many different learning experiences.

Fenstermacher and Soltis (2004:7) invoked three conceptually incompatible teaching approaches namely: the Executive approach; the Facilitative approach and Liberationist approach. Each of the teaching approaches has its own MAKER profile. Each of the five letters in the acronym MAKER presents a core element of teaching, namely Method; (M), Awareness of learners (A); Knowledge of the content (K); Ends (E) that describe the purposes and ideals for teaching; and the Relationship (R) that exists between the teacher and the learners.

The following questions illustrate the first core element namely Method: How to plan lessons? How to manage the classroom? How to construct new learning material and how to restore old material? How to make use of skills and techniques so that the learners understand the question? How feedback is given to the learners? Awareness' focal point is on the teachers' discernment of the learners. This core element illustrates what the teacher knows about the learners' interests, talents, concerns, personal history and background. Knowledge focuses on the teachers' subject capability. The focal point here is a deep understanding of the subject so that he/she can connect with the learners to make the learning of the subject more understandable. Ends has to do with the intention and purpose of the teacher, what the teacher wants to achieve in his/her teaching career. Ends focuses on the objective, thus what the learner should be able to do on achievement of a piece of work. Relationship shows the interaction between the teacher and the learner. Relationship will depend on the type of curriculum being

implemented. Answers to the following questions will contribute to describing the Relationship between the teacher and the learner. Is the intention of the teacher to focus on the transmission of knowledge, or is the teacher more sensitive to the learners (Fenstermacher & Soltis 2009:5-9)?

From this analysis a teacher's classroom and his/her approach to teaching can be described in more systematic ways as being Executive, Facilitative or Liberationist. The use of the framework can deepen the understanding of the pedagogy used by a teacher in his/her classroom.

Another value of the MAKER framework is that all the elements are under the teacher's control. For example, the teacher makes the decision of how thorough his/her understanding of Method will be; the teacher also decides on the various skills and techniques he/she will employ in the classroom. The teacher has the option to decide how Aware he/she will become of the life experiences and character of his/her learners and how this understanding will affect his/her teaching. The teacher has control over how thoroughly prepared he/she will be and how he/she will represent Knowledge to the learners. The teacher has considerable freedom to adapt Ends for his/her teaching, and to pursue them in the classroom. Finally, the teacher also decides on the kind of Relationship (strong and powerful bonds) he/she wants to have with the learner (Fenstermacher & Soltis 2004:58).

These five core elements are common in all teaching. Each of the three approaches has its own MAKER profile. The following section gives a brief explanation on each of these approaches.

2.4.1 Executive approach

The Executive approach is the first approach to teaching presented by Fenstermacher and Soltis (2004:57). According to this approach, the teacher is the manager of complex classroom processes whose main responsibility is using the best materials, skills, techniques and methods available to him/her to produce certain outcomes with the learners. In this approach the focus is on effective teaching leading to efficient learning.

Fenstermacher and Soltis (2004:57) trace the origin of this theory to the behaviourist's positivist views (cf. 2.3.2).

The overall aim of the Executive teacher is to transmit a body of knowledge or skill that learners have to acquire and to select certain methods of instruction that are most effective in conveying this body of knowledge (Fenstermacher & Soltis 2004:16). Thus, the Executive approach primarily focuses on methods of teaching and knowledge of subject matter. The Executive approach typically defines knowledge as "something out there, external to the teacher and the learner, with the teacher serving as a conveyor of that knowledge to the student" (Fenstermacher & Soltis 2004:17). Prior experiences of the learner are not emphasized and learners are believed to be without knowledge when they arrive in the classroom. The teacher is not so much an actual part of the process of managing. He/she is not 'inside' the process of teaching and learning but 'outside' where he/she regulates the content and the activities of the learner. Carefully developed curriculum materials and methods of teaching supported by research are very important to this approach. A strength of this approach is that it provides a very clear, straightforward means to move some specified knowledge from a source to the mind of the learner. It can be gathered from the discussion above that Method and Knowledge are dominant in this approach whereas Awareness, Ends and Relationship are less important for the Executive driven teacher.

2.4.2 Facilitator approach

The second approach proposed by Fenstermacher and Soltis (2004:57) is the Facilitator approach. This approach views the teacher as a human being whose mission it is to help students to become self-actualized individuals. The Facilitative teacher places a high value on what learners bring to the classroom setting and puts considerable emphasis on learners' prior experiences. Awareness of the learner is an integral part of the Facilitator approach. The teacher as a Facilitator places a great deal of emphasis on learners as persons as well as on the development of learners. The Facilitator assists learners in becoming self-actualized authentic persons, who have a sense of themselves and who will continue to develop on their own after their schooling has

concluded. It is evident that Awareness and Ends are dominant in this approach whereas Method, Knowledge and Relationship are suppressed to an extent.

2.4.3 Liberationist approach

In the third approach, namely the Liberationist approach, the teacher is viewed as a person who emancipates and opens the learners' minds, and helps them to become moral human beings. The Liberationist approach is rooted in notions of liberal education. Liberal education in general and the Liberationist approach in particular highlights initiation into two ways of knowing and the development of the learners' intellectual and moral virtues. The Liberationist approach attaches primary importance to Knowledge. The Liberationist approach places some strict controls on what can be considered as Knowledge and as a result on what is proper to the curriculum. The Ends of education, in the Liberationist approach, is for learners to take up membership in civilized life. The Liberationist teacher aims at developing learners who are solely knowledgeable but "persons who are also just and loving, who are imaginative in thoughts and discerning in conduct, and who are committed to the advancement of humankind" (Fenstermacher & Soltis 2004:46). It is clear from the prior discussion that Knowledge and Ends are dominant in this approach whereas Methods, Awareness, and Relationship are more covert in this approach.

The Liberationist, like the facilitator, teaches in order to realize certain Ends for students. Unlike the Facilitator, the Liberationist emphasises Ends and Knowledge, while Method, Awareness of the learner and Relationship play a smaller role. The Liberationist approach rooted in notions of liberal education, to open up the mind to ask questions, to know and understand, to imagine and create, using the full heritage of civilised life. Thus, the Liberationist therefore strives for the creation of learners who are highly capable in reasoning, judgment and moral conduct.

According to Fenstermacher and Soltis, it is not sufficient for teachers to rigidly follow the script for an Executive, Facilitative and Liberationist approach. Teachers should explore the ideas behind each of the three approaches. This will enable them to discover where they stand in these three approaches. Fenstermacher and Soltis

believed that it is important for teachers to be comfortable with all three approaches. Even though every teacher may have a preferred approach for certain instructional situations one or more of these three approaches might be more effective. Using all three of these approaches prepares one “to function well in different school settings, with different learners, who are in various stages of development at any given moment and passes a huge diversity of temperaments, needs, and interests” (Fenstermacher & Soltis 2004:73).

2.5 SUMMARY

In this chapter, the researcher discussed the cognitive learning theories of Piaget, Vygotsky, Kolb and De Corte, and the social and cognitive theories of knowledge of Durkheim, Bernstein, Bandura and Young. The Pedagogical Content Knowledge views of Shulman and Ball were also discussed. The researcher represented these theorists to seek and understand learning and knowledge in the Education context.

According to Piaget the growth of knowledge is the result of individual constructions made by the learners’ understanding. He stated that the current state of knowledge is temporal and changing as time passes as knowledge in the past has changed, it is not a static instance; it is a process. Durkheim declared that the social is the moral – a set of collective representations which grows out of communities is the paradigm of all advanced forms of theoretical knowledge. This chapter also discussed the experiential learning cycle of Kolb. Kolb stated that learning takes place through experience. Vygotsky’s key interest was in how natural human activity serves a major force for learning; in fact, learning can be understood as an activity. Furthermore, learning is a social and culturally-based activity, with social interaction, social history, all playing a major role in pedagogy. He also believes that language plays an important role in the social and cultural interaction in human development. Bernstein described different forms of pedagogy and knowledge and his notions of boundaries and specialization – all of which imply power relations. Young emphasized the terms Powerful Knowledge and Knowledge of the Powerful. He highlighted the significant overlap between Powerful Knowledge and the Knowledge of the Powerful. According to Shulman Mathematical facts, procedures, concepts as well as how knowledge is generated and structured are

important in Education. He highlighted the importance of SCK, PCK and CK. Ball agreed with Shulman (1986) that a particular kind of Content Knowledge is especially suited to teaching. Teachers' knowledge plays a central role in what is taught, as well as, how learners learn. Ball's theory is widely acknowledged and represents an important extension of understanding of the knowledge of a Mathematics teacher.

Teaching entails guiding learners in different ways to help learners gain knowledge and to enable learners to implement what they have learned. In this chapter three teaching approaches were discussed namely the Executive approach; the Facilitative approach; and the Liberationist approach. The MAKER's framework highlighted the pedagogy exercised in each of these teaching approaches.

In this chapter the first two objectives of this study were partly investigated. Learning and teaching and the connection to knowledge, with the emphasis on Mathematics, were examined.

The third objective will partially be investigated in the literature study in Chapter 3. Classroom assessment in a Mathematics classroom and the role of the ANA on the process of assessment will be examined.

CHAPTER 3

ASSESSMENT

Assessment is at the heart of the student experience.

Brown and Knight

3.1 INTRODUCTION

In Chapter 1, the researcher outlined the aim of the research study which is to investigate the nature and extent of the influence of the ANA on the Mathematics pedagogy in a Grade 9 Mathematics classroom. Chapter 2 addressed the beliefs of different cognitive learning theories of Piaget, Vygotsky, Kolb and De Corte as well as the social and cognitive theories of knowledge of Durkheim, Bernstein, Bandura and Young and the influence thereof on pedagogy. It also addressed the Pedagogical Content Knowledge views of Ball and Shulman. To address the overarching aim of this study, namely the influence of the ANA on teaching, learning and assessment, this chapter takes a closer look at the concept of assessment. It starts with an observation of the views on assessment, as well as the purpose of assessment and different types of assessment before continuing to explain the alignment between teaching, learning and assessment and the role that assessment standards play in aligning teaching, learning and assessment. The ANA as an assessment instrument in the teaching and learning of Mathematics at Grade 9 level, as well as the cognitive domain levels of Bloom, Anderson and Krathwohl will be investigated in this chapter.

3.2 VIEWS ON ASSESSMENT

According to William (2010:107-122) assessment is the core process of education and therefore it is an important concept in education (Siebörger & Macintosh 2002:5 in Msila 2009:542). William (2010:107-122) believes that it is only through assessment we can find out whether teaching has reached its intended effect. William (2010:107-122) goes

a step further and argues that “all those with a stake in the outcomes of education – learners, teachers, parents, other taxpayers, employers, and the wider community – want to know what students have learned, and it seems reasonable that this can easily be evaluated through the use of straightforward and familiar instruments, such as tests”.

Examples of standardized tests are the Standard Assessment Task (SATs) in England, the National Test (NT) in Scotland, the National Assessment Program – Literacy and Numeracy (NAPLAN) in Australia, the National Assessment of Educational Achievement (NASA) in Korea and the Annual National Assessment (ANA) in South Africa. These tests focus on ‘achievable outcomes’ (Orga 2003:2) and the purpose of these tests are to assess the range of skills and knowledge of learners in a specific subject (Jeffrey 2002:531-546). The use of standard-base assessment (Kelchtermans 2005:3) for the purpose of educational accountability is not new (Brkich & Washington 2011:36-57). Kim (2010:71-72) who writes from a Korean perspective, believes that standardized tests demonstrate if the learners have achieved the national curriculum standard. In England learners at the ages of 7, 11 and 14 (Fitz 2003:233; Peters 2004:22; Volansky 2007:15) are assessed to ‘achievable targets’ in subjects like English, Mathematics and Science. In Australia there is a National system of standardized tests in Grades 3, 6 and 9 and in Korea there is a National system of standardized tests in Grades 6, 9 and 10 (Kim 2010:71). In South Africa the ANA test is a system of National standardized tests to assess learners’ skills of Numeracy and Literacy in Grades 1 to 6 and 9 (Spaull 2013:14).

The following section focuses on the purpose of assessment in a Mathematics classroom.

3.3 PURPOSE OF ASSESSMENT

According to Herman (1992:75) the extent to which assessment promotes the motivational desire to learn and to continue learning is an important aspect relating to the quality of assessment. During the process of assessment learners should develop the skills and understanding they need to continue their progress in the world of further learning and training.

According to the Department of Education (DoE 2003:65) assessment should:

- Be understood by the learner.
- Be clearly focused.
- Be integrated in teaching and learning.
- Be based on the pre-test criteria of the assessment standards.
- Allow for expanded opportunities for learners.
- Be learned-paced and fair.
- Be flexible.
- Be executed by using a variety of instruments.
- Be executed by using a variety of methods.

Van den Heuvel-Panhuizen and Becker (2003:698) stated that the process of assessment should move from passive to active, from static to dynamic, from uncertainty to certainty and from problems on different levels to answers on different levels (cf. 3.9). Thus assessment should be objective instead of being subjective. According to the DoE (2003:73) the purpose of assessment must be clear and unambiguous. The understanding of assessment guarantees that an appropriate correspondence exists between the purpose and methods of assessment. The major purpose of conducting classroom assessment is to obtain information about learners' progress in learning and the achievement attained (McMillan 2007:1-7). According to the DBE assessment is a continuous planned process and should include both formal and informal assessment activities. Regular feedback should form part of the assessment process to enhance learning (DBE 2011:154).

Weeden *et al*. (2002:19-20) viewed the purpose of assessment as diagnostic, formative, summative and evaluative. In short the meaning of these elements of the purpose is as follows:

- Diagnostic – diagnose the learners' weaknesses and strengths.
- Formative - aid the learning process.
- Summative - for reviewing and grading.
- Evaluative - how well teachers or institutions are performing.

It is thus obvious that the purpose of assessment is closely linked to the type of assessment (Killen 2010:369). The following section discusses the different types of assessment.

3.4 TYPES OF ASSESSMENT

Lombard (2010:31-62) explained that if the purpose of assessment is for example to determine the entry level of learners to a new learning experience, the baseline assessment should be used. Diagnostic assessment should be used when the purpose is to determine the possible barriers experienced by learners while authentic assessment should be used when the purpose is to determine learners' ability to transfer and apply knowledge, skills and values in situations resembling real-life contexts. Teaching success and learner development should be determined by means of formative assessment, whereas the learning success at the end of a learning experience should be determined by means of summative assessment (Lombard 2010:31-62). Maree (2004:14) underlined the different forms of assessment reviewed below. These include baseline, diagnostic, formative, summative, inclusive, performance-based, authentic and continuous assessment.

3.4.1 Baseline assessment

Baseline assessment usually takes place at the start of a phase to establish what learners already know. It assists teachers to plan their learning programmes and learning activities (Maree 2004:14). Baseline assessment establishes whether learners meet the basic skills and knowledge levels required to learn a specific Mathematics topic. In Mathematics baseline assessment can be used to determine whether learners can develop products and factorize before engaging with the solving of quadratic equations. Knowing learners' levels of proficiency in a particular Mathematics topic enables the teacher to plan the Mathematics lesson appropriately. Baseline assessment is not for promoting purposes (DBE 2011:154).

3.4.2 Diagnostic assessment

Diagnostic assessment is used prior to teaching and provides the teacher with planning information. The strategies of diagnostic assessment may be formal. A commonly used formal diagnostic assessment is a pre-test, which is a measure of the learner's knowledge (Maree 2004:14). It is the key tool used by teachers in planning lessons and setting proper learning goals. Diagnostic assessment provides information that is used by teachers and learners to determine what students already know and can do pertaining to the knowledge and skills identified in the overall and specific expectations (Ontario Ministry of Education 2013:146). Diagnostic assessment is not for promoting purposes, but to inform the teacher about the problems that learners experience that might have the potential to influence performance in Mathematics (DBE 2011:154). The ANA is based on similar cross-national and regional studies such as the Southern and Eastern Consortium for Monitoring Educational Quality (SACMEQ) and the Trends in International Mathematics and Science Study (TIMSS), but targets a more diagnostic interpretation of learners' achievements (DBE 2014b:14).

3.4.3 Formative assessment

According to Sadler (1989:145-165) formative assessment refers to assessment that is specifically intended to generate feedback on performance to improve and precipitate learning. Formative assessment is a regular process to constantly gather proof about learning. Data are used to identify a learner's current level of learning and adapts lessons to help the learner reach the desired learning goal. In formative assessment learners become active participants with their teachers, sharing learning goals and understanding how their learning is progressing, what steps they need to take and how to take these steps to achieve learning (Heritage *et al.* 2009:26). Harris and Bell (1994:99) stated that formative assessment is a 'learn as you go process' as it helps learners to answer their questions. The underlying objective of formative assessment is to improve learning, as it indicates to the learner and the teacher whether the targeted learning outcomes have been achieved. In practice the teacher has to actively engage their learners in discussing their performance. Formative assessment should occur regularly throughout the instructional process. The teacher employs the results of

formative assessment solely to modify and adjust his/her teaching practices to reflect the needs and progress of his/her learners. According to Maree (2004:34) formative assessment is integral to learning and takes place throughout learning. This form of assessment is seen as being supportive and non-judgemental and focuses on providing constructive criticism to learners. Oliver (1998:67) observed that formative assessment influences teachers to provide counteractive actions since instruction is intended to enhance learning.

Close links can also be made with one of the well-established learning models such as Kolb's (1984:41) model of experiential learning developed from the work of Lewin (1890-1947) (cf. 2.2.3).

Formative assessment can be used to establish Kolb's concrete experience (see Figure 2.1) where learning occurs during the assessment process. This allows learners to participate on a personal level in a particular task. Feedback can be used to inform the reflective observation where learning from assessment takes place (this can also be part of the systematic reflection process on the experience or learning). Feedback can also be used to provide guidance on the abstract conceptualization where learning takes place through feedback (cf. 3.6). The active experimentation encourages learners to try things out based on the formative assessment experiences (Kolb 1984:41).

Formative assessment is used to support the teaching and learning process in the classroom. According to the CAPS of Grades 7-9 (DBE 2011:154), lesson plans should incorporate informal assessment such as: observation, discussion, practical demonstrations, learner-teacher conferences and informal classroom interactions. Assessment may be done by simply stopping during a lesson to observe learners or to discuss with learners how their learning is progressing. Consequently, formative assessment is seen as informal assessment and as daily monitoring of learners' progress.

3.4.4 Summative assessment

According to Van der Horst and McDonald (1997:176) summative assessment takes place at the end of a learning experience. Maree (2004:32) states that summative

assessment is used to make conclusions about the achievement of learners at a particular point of a learning programme. This means that this is the kind of assessment that produces a measure that summarizes someone's achievement and has no other real use apart from describing what has been achieved (Dreyer 2008a:5). McTighe and O'Conner (2005:10-17) defined summative assessment as a tool that explains what learners have learned at the end of a lesson. The results are reported as a grade or at a level. Thus, summative assessment can be defined as an instrument that summarizes how much a learner has accomplished at a particular point in time. This definition applies to a benchmark progress.

In a Mathematics classroom summative assessment is carried out after completion of a Mathematics topic such as solving linear equations. Summative assessment of learning focuses on the product of learning. Usually formal assessment tasks are summative and are subject to moderation for the purpose of quality assurance and to ensure that appropriate standards are maintained (DBE 2011:155).

When distinguishing formative assessment from summative assessment the following differences are clear (William 2005:20-34):

Table 3.1: Differences between formative and summative assessment

Formative Assessment	Summative Assessment
Occurs during instruction	Occurs at the end of instructional unit
Focuses on process towards completing learning process	Focuses on product after learning has been completed
Helpful diagnostic information about learning	Summarizes the learning that has taken place during the learning process
Promotes learning-not grading	Monitors learning-grading
Descriptive feedback	Evaluative feedback
Process	Product
Informal	Formal

In Table 3.1 the first two characteristics were made referring to the time frame. Formative assessment occurs during a lesson while summative assessment occurs at the end of a lesson (day or week). Formative assessment is a constant minute by minute (William 2005:20-34) process while summative assessment is periodic (daily, weekly or yearly). The third and fourth characteristics show that formative assessment is a process towards completion of a unit, while summative assessment shows that it is the assessment after learning has been completed. Characteristic number five shows that the intention of formative assessment is to promote learning and in contrast with this, summative assessment aims rather to monitor learning. Characteristic number six relates to feedback (cf. 3.6). Formative assessment is related to descriptive feedback. Descriptive feedback describes to a learner how to improve learning (cf. 3.6.1.2). Summative assessment is related to evaluative feedback. Evaluative feedback (cf. 3.6.1.1) summarizes a learner's performance but does not provide any information on how to improve learning (Stiggins *et al*. 2006:33). The second last characteristic shows that formative assessment is a process while summative assessment is a product, for example a formal test. The last characteristic shows that formative assessment is informal while summative assessment is formal. Formal assessment involves gathering evidence of learning to adjust teaching and/or learning. Formative and summative assessment should be combined to ensure that one complements the other.

From the discussion above it is evident that both assessment processes are important in the teaching and learning process.

3.4.5 Inclusive assessment

Inclusive education is a process that describes the process by which a school attempts to react to all learners as human beings, by reviewing and limiting its curricular organization and by providing and assigning resources to enhance the quality of opportunity (Hyam 2004:36). For inclusive education to take place inclusive assessment is required. Dixon-Krauss (1996:127) identified two aspects in inclusive assessment: involvement of a learner in a highly difficult learning task; and a learner's presentation of this task. Engelbrecht *et al*. (1996:6) however described inclusive assessment as a shared value that supports a single system of education where all learners are

empowered to become concerning, experienced and contributing citizens in an inclusive, changing and diverse society. Inclusive assessment also increases the chances that learners can reveal that they have achieved the learning outcome without compromising academic standards (Waterfield & West 2007:3-11). The prominent target of schools in the education system is to provide quality education to all learners (Prinsloo 2001:344-348). International reports like The Salamanca Statement and Framework for Action on Special Needs Education (UNESCO 1994 in Logan 2008:92-99) emphasize the right of the child to inclusive education.

According to the DBE (2011:4) the vision of the Department of Basic Education is to equip learners, irrespective of their socio-economic background, race, gender, physical ability or intellectual ability, with knowledge, skills and values. The DBE attempts to be sensitive towards issues of poverty, inequality, race, gender, age, disability, and challenges such as HIV/AIDS. As a result the DBE adopted an inclusive approach for all learners (DBE 2011:5).

3.4.6 Performance-based assessment

According to Maree (2004:52) performance-based assessment requires the establishment of skills of proficiency through creating, producing or doing something. Airansia (2001:228) affirmed that learners have to demonstrate their ability to structure their thoughts and express their ideas. This implies that the use of a range of tasks that involves learners in many learning activities, can lead to a spectrum of final demonstrations. The aim of performance-based assessment is then to rather assess performance of learners directly instead of using normal assessment methods like paper and pencil tests. If curriculum, instruction and assessment are combined, this type of assessment becomes a valuable learning experience (Moskal 2000:192-194).

The performance policy in the form of targets, tests and assessments is absolute (Troman *et al.* 2007:555). The growing trend to evaluate education is associated with a culture of performance (Brix *et al.* 2014:85). The quality of a teacher is rated according to the performance of learners - especially tests and examinations (Tolofari 2005:87). Standardized tests' main purpose is to compare learner achievement to curriculum

standard (Volansky 2007:21). Standardized tests, for example the ANA, are to monitor and assess if learners have reached the national curriculum standard. Prior to 2011, the Grade 12 end examination was the only standardized test that existed in South Africa. After 2011, the ANA was implemented. As mentioned earlier the ANA test (cf. 3.2) is a system of national standardized tests to assess learners' skills and knowledge of literacy and numeracy. According to Tolofari, (2005:86) the performance of learners in these standardized tests (cf. 3.2) reflects the performance of the teacher, hence performance is *raison d'être* (reason for existing) in education.

3.4.7 Authentic assessment

Fraser (1999:15) stated that authentic assessment focuses directly on learners' performance. Fraser explained that authentic assessment resembles skills, activities and functions in the real world and in school. The aim of authentic assessment is to determine competences in context that resemble situations closely. The learning experience can then be assessed where learners' skills and values can be tested in an integrated manner. This assessment is called authentic because it involves learners in real world tasks rather than in multiple-choice exercises. Assessment takes place according to criteria that is important for real performance (Wiggins 1989:703-713).

3.4.8 Continuous assessment (CASS)

Van der Horst and McDonald (1997:172) are of the opinion that continuous assessment forms an integral part of teaching and learning. This view is also shared by Dreyer (2008b:16) who claimed that the term CASS is used to describe the constant process of assessment that spans the entire learning process. Geyser (2004:101) referred to CASS as the regular manner that assessment takes place and that integrates teaching, learning and assessment. CASS in this context refers to a cyclic process that includes various assessment methods and instruments that display a holistic picture of the learners' competence. A major feature of CASS is the feedback from each assessment that informs the teacher how to adapt his/her teaching strategy in order to provide quality and effective assessment to learners. In Figure 3.1 an adapted diagrammatic presentation of continuous assessment is displayed (Dreyer 2008b:16).

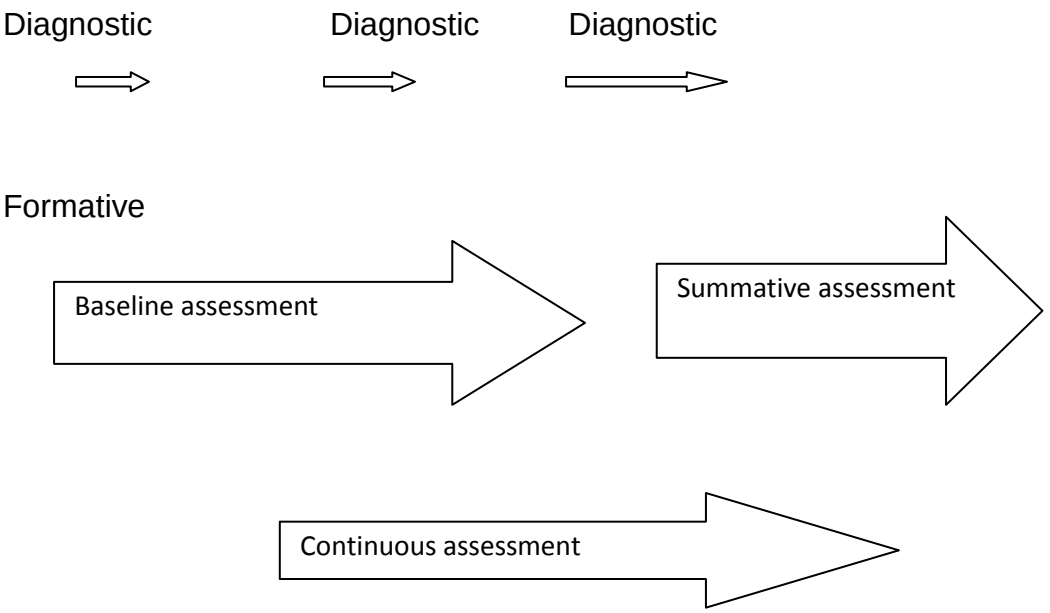

Figure 3 1: Continuous assessment

Adapted from Dreyer (2008b:16)

3.4.9 Link between different types of assessment

The following diagram shows the link between different types of assessment (DoE 2008:76).

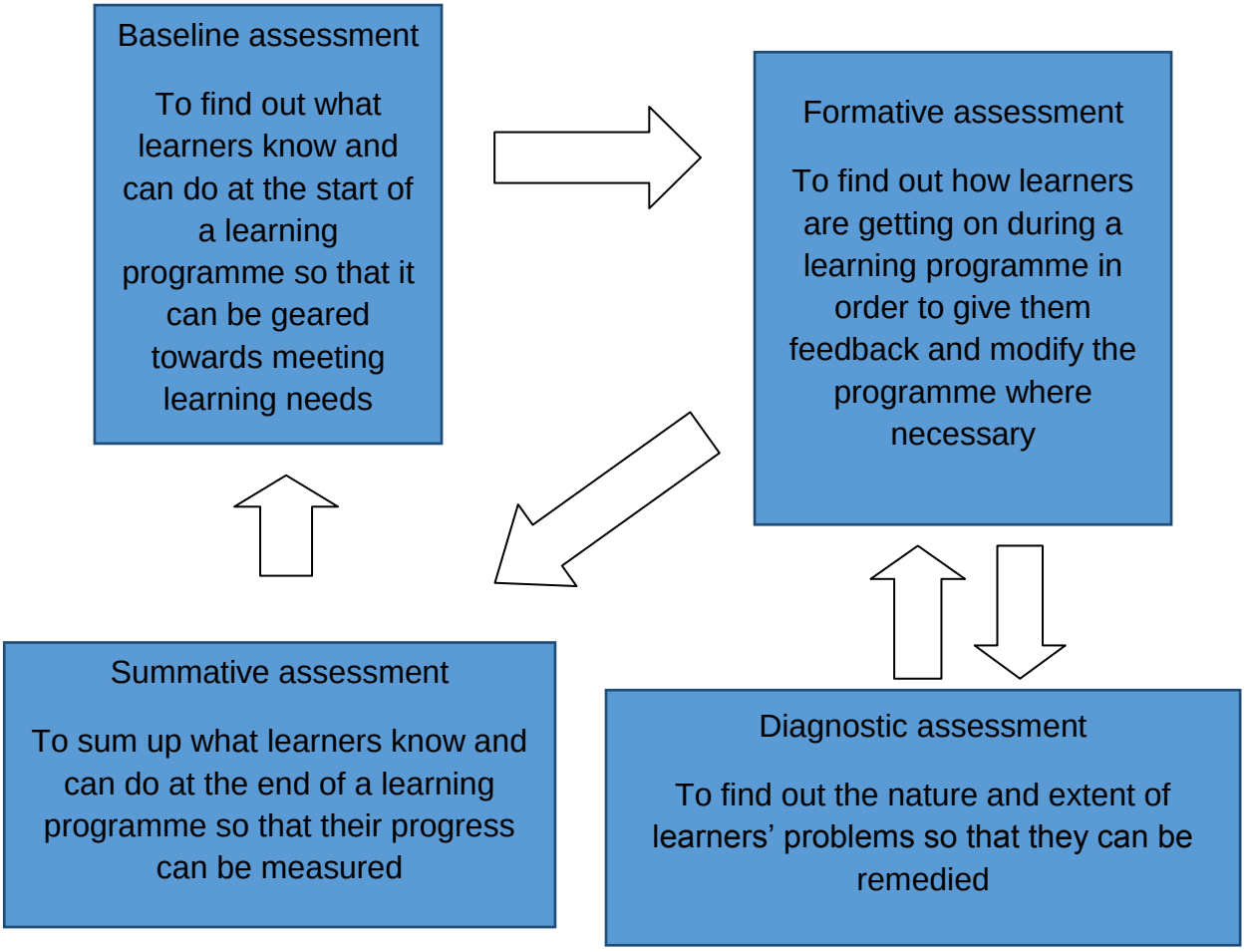

Figure 3.2: The link between different types of assessment

DoE (2008:76)

Assessment should be an ongoing process as illustrated in Figure 3.2. Although baseline assessment (cf. 3.4.1) should be done at the beginning of a learning experience the cycle shows that baseline assessment should be done continuously throughout the learning experience aiming at identifying prior knowledge. The importance of linking new knowledge with learners' existing knowledge, was proposed by Bernstein (cf. 2.3.3) and was emphasized in this research study. Baseline (cf. 3.4.1), summative (cf. 3.4.4) and formative assessments (cf. 3.4.3) are ongoing processes, where the basic principle is to find out what learners know and can do.

3.5 ALIGNMENT OF ASSESSMENT, TEACHING ANDLEARNING

According to Birenbaum (2003:15) an important aspect of relating to quality refers to the extent to which assessment promotes the motivational desire to learn and to continue learning. Through the process of assessment learners should develop the skills and understanding they need to continue their progress in the world of further learning. Focusing on assessment will ensure that learners are also learning and demonstrating the intended outcomes (Biggs & Tang 2007:190). Activities where learners are being engaged in may result in them developing a deeper understanding of the material. According to Black and William (1998a:139-148) learning can be improved through assessment by associating it with factors such as:

- Active contribution of learners in their own learning.
- Modifying teaching and taking results of assessment into account.
- To recall the profound influence assessment has on the motivation and confidence of learners.
- The necessity for learners to be able to assess themselves and understand how to progress.
- The presenting of effective feedback to learners.

Van der Horst and McDonald (2003:166) explained that it is important that assessment procedures should give a clear indication of what learners are learning. Dreyer (2008a:7) stated in this regard that it is essential to determine if teachers' instructions are assisting learners in their progress towards the achievement of learning outcomes and to eventually establish whether learners have learned what was expected of them. This calls for carefully designed assessment activities and requires that the teacher should determine in advance exactly what it is that they want learners to learn and why they want them to learn it. According to Van der Horst and McDonald (2003:166), this is sometimes called curriculum alignment: "What is taught must directly link up to what is assessed and vice versa".

Biggs (2003:26-27) went further and stated that teachers have to be careful to seek compatibility between the curriculum objectives, the teaching and learning activities and

assessment procedures, because “when there is alignment between what we want, how we teach and how we assess, teaching is likely to be much more effective than when there is not”. The close link between teaching, learning and assessment can also be found in the discussion of assessment in the CAPS for Mathematics (DBE 2011:154). As mentioned earlier (cf. 1.1) this document states that assessment is a continuous planned process of identifying, gathering and interpreting information about the performance of learners, using various forms of assessment. It involves four steps: generating and collecting evidence of achievement; evaluating this evidence; recording the findings; and using this information to understand and thereby assist the learners’ development in order to improve the process of learning and teaching. This explanation emphasizes the close link that should exist between teaching, learning and assessment.

De Jesus and Moreira (2009:195) justified the importance of aligning assessment with learning and instruction by explaining that assessment is at the centre of learners learning experiences and that the demands of assessment and activities often determine learners’ engagement in learning. The teaching, learning and assessment process cannot be achieved without the proper direction given by the assessment standards because they indicate the right path towards the achievement of the outcomes to both the teacher and the learner. In short, assessment standards serve as linkages between teaching and learning and learning and assessment. Cowdroy and Williams (2007:89) confirmed this when they shared that what teachers assess and how they assess, are guided by the assessment standards (cf. 3.9). According to Sleeter (2005:3) standards specify what learners must know and be able to do. It describes how well learners are expected to master a given quantity of knowledge and skills, and it specifies what learners should know and how learners should be assessed. This reveals that learning, teaching and assessment are inextricably linked. It is only in the context of the other that each has meaning and without learning, assessment has relatively little value; without assessment, the effectiveness of learning and the accountability of teaching cannot be determined (DoE 2008:21, 46-47).

Burger (2008:4) stated that the alignment of the teaching, learning and assessment process is the key to achievement of the learning outcomes: that instruction must be

planned in such a manner that there is a clear link or alignment between what is taught, learned and assessed and the most prominent directives in this regard are the assessment standards.

According to Lombard (2010:31-62) teaching, learning and assessment are integrated and form a powerful, concerted whole which stimulates learning. Killen (2010:vii) stated that there are four questions which guide decisions about planning, teaching and assessment, namely:

- What do we want learners to learn?
- Why do we want learners to learn?
- How can we best help learners to learn things?
- How will we know when learners have learned?

Killen's four questions do not only give guidance in respect of planning, teaching and assessment, but also explain the close link between teaching, learning and assessment. The first two questions refer to the learner, what he/she is supposed to learn and confirmation on the part of the teacher regarding the value of what the learner learns. The third question refers to delivery, instruction and how the teacher will facilitate the learners' learning. The fourth question relates to assessment and how teachers will determine whether the learners have learned what they have been taught (Blumberg 2009:93-103). The close link between teaching, learning and assessment is also assured by Siebörger and Macintosh (2004:7) when they stated that the teacher helps learners to learn (by teaching them) and that assessment is one of the ways to help learners to learn.

According to the above discussion it is clear that assessment is integrated in teaching and learning because it is the driving force behind achievement. The next figure shows the cyclic nature of assessment (Gawe & Heyns in Maree & Fraser 2004:171).

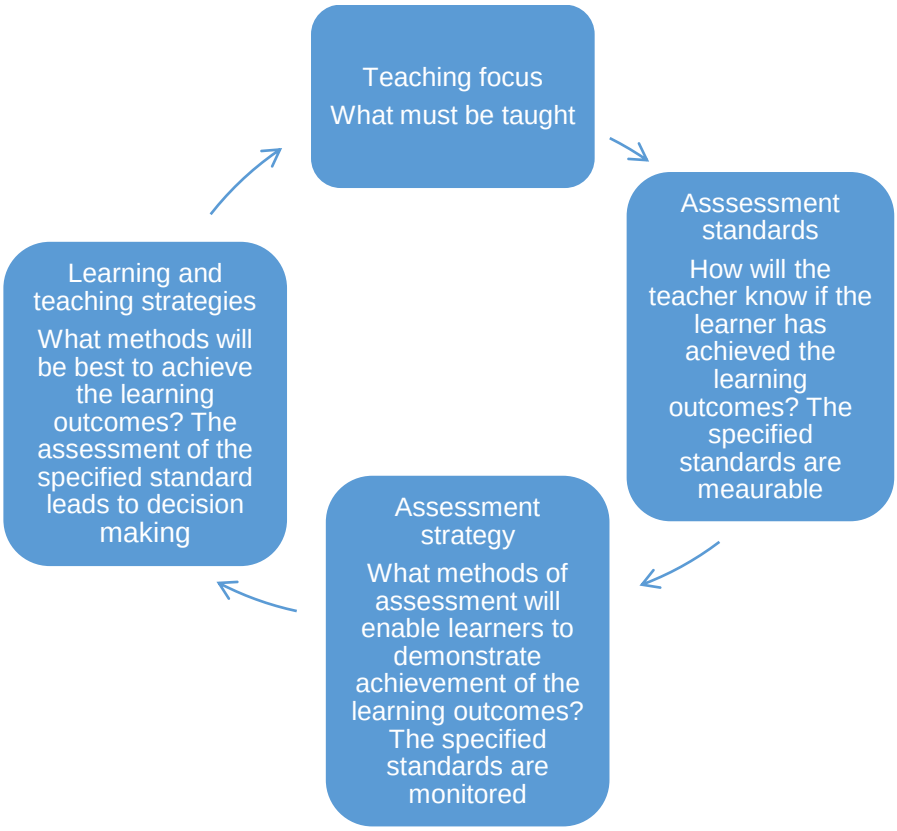

Figure 3.3: The cyclic nature of assessment

Gawe and Heyns in Maree and Fraser (2004:171)

Gawe and Heyns in Maree and Fraser (2004:171) believed that assessment is a cyclic process which integrates learning and teaching. All educational assessment practices should be underpinned by the learning, teaching and assessment principles.

Assessment and feedback are crucial for learning. In order to gain insight into the learning and their understanding of learners, frequent feedback is critical. The following section focuses on feedback.

3.6 FEEDBACK

Feedback provides information to teachers and learners about the learning process. It helps to reduce the gap between the learners' current level of understanding and/or performance and a desired goal. Feedback can have powerful positive effects on

learners' learning and engagement depending on the nature and delivery of the feedback (Hattie & Timperley 2007:81-112). There is an inextricable link between feedback and learners' performance and this can be described as "a process of seeking and interpreting evidence for use by learners and their teachers where the learners are in their learning, where they need to go and how best to get there" (Assessment Reform Group 2002).

Gipps and Tunstall (1996:389-404) identified two types of feedback: evaluative and descriptive feedback.

3.6.1 Types of feedback

3.6.1.1 Evaluative feedback

Evaluative feedback is related to summative assessment. Evaluative feedback gives the learner a summary of how he/she has performed but not any information about how to improve the learning process. This can have a negative effect on learning and motivation (Black & William 1998a:139-148; Gipps & Tunstall 1996:389-404). In Mathematics evaluative feedback can be used in tests or examinations at the end of a section.

In many countries it is expected of teachers to collect assessment data and to report the data to learners (Jeffrey 2002:532) as well as to parents. The results, in the form of tables, are then published in local and international newspapers as well as on websites (Surgrue 2006:191). In countries like the United Kingdom, Ireland and Netherlands the government plays an important role to represent the performance of learners (De Wolf & Janssens 2007:382). The tables that are made available to the public are an indication of the success or failure of the school (Tan 2008:111-120).

3.6.1.2 Descriptive feedback

Descriptive feedback is related to formative assessment. Learners are given a summary of what was done and what is needed to improve and how to improve (Stiggins *et al*.

2006:33). Thus descriptive feedback helps learners to learn by providing information about their latest achievement (Where am I now?) with respect to a target (Where am I going?) and identifying appropriate next steps (How can I close the gap?) (Stiggins *et al.* 2006:33). An example of descriptive feedback in Mathematics is an investigation, class test or project that the learner has to hand in and that does not count towards a formal mark.

3.6.2 Principles of feedback

The following principles can be used to guide the process of feedback (AssessForum 2008:3). Feedback should:

- Be part of assessment with the process of receiving and responding to feedback built into and made clear in subsequent learning experiences and grading.
- Be constructive, so that learners feel encouraged and motivated to improve their practice, and contributing their positive self-esteem as learners.
- Be timely, so that learners can use it for future learning and work to be submitted.
- Happen without delay, so that the learners can recall what they did and thought at the time.
- Be verified, by being based on clear explanations of performance against stated criteria and standards.
- Be supportive of learning, so that learners have a clear indication of how to improve their performance.
- Be focused, on achievement, not effort; and on the work, not the learner.
- Be stated in terms of the learning outcomes, so that learners can link their assessment to the learning outcomes, seeing how they can close the gap between their existing and their desired achievement.

From the above discussion it is clear that feedback to learners should focus on the particular work that was done and should contain advice on how the learners can improve.

When linking formative assessment (cf. 3.4.3) to feedback discussion, the following question can be asked: Do the ANA tests value only the results of learners' problem solving and computation, or does it also consider how well learners understand and can apply the importance of Mathematics?

3.7 ANNUAL NATIONAL ASSESSMENT (ANA)

For many years in South Africa the focus has been on learner performance at Grade 12 level. This created much publicity around the Senior Certificate (Grade 12) examination results. Over the last few years there has been a strong insight to improve the performance of learners in lower grades. One of the outputs of the *Action Plan to 2014: Towards the Realization of Schooling 2025* is the movement towards increasing the number of learners in Grade 9 who, by the end of the year, have mastered the minimum Language and Mathematics competencies for Grade 9. The priority of the DBE is to establish a world class system of standardized national assessment tests (such as the ANA). These standardized tests are comparable across provinces and schools (DBE 2013:2-3).

In South Africa, the results of the ANA tests are reported in narrative and table form in the Department of Education's Diagnostic Report. According to DBE (DBE 2014a:8-9) this Diagnostic Report of the ANA outlines the levels and quality of skills and knowledge that the assessment identified in the system. The purpose of the ANA Diagnostic Report is to inform the learners, teachers, principals, management of curriculum implementation and management at national and provincial levels to implement appropriate interventions to improve the quality of teaching and learning in basic education. Thus, the Diagnostic Report of the ANA is crucial and should aim to improve teaching and learning in schools. The Diagnostic Report reveals an analysis to identify the content knowledge and skills learners were able or not able to demonstrate in the ANA test (DBE 2014a:4). Thus, information in the Diagnostic Report shows areas where learners are strong and areas where they experience challenges. This report from the DBE is both descriptive and evaluative (cf. 3.6.1.1; 3.6.1.2).

According to the DBE (DBE 2015b:23) scripts should be returned to teachers and learners so that they can determine what went wrong and how they can improve and fix their errors. The DBE also stipulates that school principals must ensure that parents receive the moderated ANA results at least three to four weeks after the tests were written (DBE 2015b:23).

From the above discussion it is clear that the feedback of the ANA test is crucial to classroom learning and teaching.

3.8 EVALUATION OF ASSESSMENT

3.8.1 Difference between evaluation and assessment

According to McMillan (2000:1) assessment is a process where evidence of what a learner can do is gathered. Evaluation is the process that follows this collection of data, it includes analysis and reflection, as well as decisions based on the data.

3.8.2 Criteria for evaluating assessment

Reliability refers to how consistently an assessment measures learners' knowledge, skills and understandings. To be reliable, the results of an assessment should be consistent across the different test items intended to measure the same knowledge and skill. Another criterion used to evaluate assessment is validity, which refers to the extent to which an assessment measures what it is intended to measure, and the accuracy and decisions made on the basis of the assessment results (O'Leary 2004:5). To be valid, an assessment should also be fair, or equitable; that is, it should enable learners to demonstrate their Mathematical competence, regardless of their language, cultural background or physical disabilities (DBE 2011:5). An additional criterion used to evaluate assessments which has earned increased attention in the past decade is the extent to which a test is aligned with the curriculum that learners are using in the classroom. If a test includes items that require knowledge and skills not included in the curriculum, then it is not well aligned with what learners are expected to learn in school (cf. 3.5).

The question arises to what extent the ANA as evaluative assessment practice answers to these criteria? However, determining the significance of an ANA test requires more than just a score. For instance, what is the content of the ANA test? To what extent is that content part of the curriculum? Moreover, although standardized tests are designed to provide information about individual learners in relation to a comparison group, these tests are often used to make assumptions about the efficiency of education. These tests have errors both as measures of individual learners' achievement and as indicators of the success of teachers and school. Learners' knowledge of Mathematical facts, algorithms and concepts in isolation does not ensure that they understand them, can call them up and can use them appropriately in problem-solving (Graven & Venkat 2014:299-310).

3.8.3 Standards for evaluating assessment

Many developments in education policies are designed to raise standards of learners' achievement. There are competing claims for ways in which assessment standards can be raised. The National Curriculum Statement places the assessment standards at the centre of the assessment process in every grade. These assessment standards give a description of the expected level of performance and the range of performance for each of the learning outcomes for every grade.

Webb, Herman and Webb (2007:17-29) argued that the important role of assessment standards in guiding teaching, learning and assessment cannot be over-emphasized. The teaching, learning and assessment process cannot be achieved without the proper direction given by the assessment standards because they indicate the right path towards the achievement of the learning outcomes to both the teacher and the learner. In brief, assessment standards serve as linkages between teaching and learning and learning and assessment. Cowdroy and Williams (2007:89) confirmed this when they stated that what we teach and how we teach it, what learners learn and how they learn it, as well as what teachers assess and how they assess it, are guided by the assessment standards. As Vandeyar and Killen (2003:123) stated, what teachers teach is that which they will assess and what is assessed is that which is obtained from the

assessment standards. This shows that learning, teaching and assessment are inextricably linked. It is only in the context of the other that each has meaning: without learning, assessment has relatively little value; without assessment, the effectiveness of learning and the accountability of teaching cannot be concluded.

One of the aims of the ANA is to improve the quality of assessment practices in schools by providing a tool for teachers to diagnose learning gaps based on the requirements of the curriculum (DBE 2014b:6-8) (cf. 3.7). Although assessment is seen as a tool to measure the progress of individual learners, it also allows individual, communities and countries to track the quality of schools and the education system. Braun *et al.* (2006:1-47) theorized that a systematically valid test is one that induces in the education system curricular and instructional changes that raise the development of the cognitive skills that the test is designed to measure. High stake tests like the ANA can, and do cause learners and teachers to focus their efforts on maximizing test scores which result in teachers 'teaching to the test'. This often results in negative consequences for the general quality of pedagogy such as the narrowing of the curriculum and an excessive emphasis on test preparation. According to Kellaghan and Greany in Braun *et al.* (2006:1-47) assessment policies in most countries focus primarily on the examination with little or no importance on classroom assessment.

According to Dreyer (2008a:5) summative assessment is the assessment which produces a measure that sums up someone's achievement. The ANA test is an assessment test which reports and describes learners' achievement and therefore the ANA test can also be seen as a summative assessment tool. The predominant target of schools in the education system is education for all learners, thus inclusive education. Inclusive means to include learners of all cultures, all deficiencies and needs. Thus, the ANA test can also be seen as an inclusive assessment tool.

The taxonomy of Bloom on the cognitive domain provides levels on which learners must be able to perform. These levels can be seen as an indication of the standard at which learners should demonstrate their competencies.

3.9 BLOOM'S TAXONOMY: THE COGNITIVE DOMAIN

Taxonomy is a system that describes, identifies and classifies groups. According to Bloom *et al.* (1956:10), the major purpose in constructing a taxonomy of educational objectives is to facilitate communication. The use of the taxonomy as an aid in developing a precise definition and classification of such vaguely defined terms as thinking and problem solving would enable educators to discern similarities and differences among the goals of their different instructional programmes. They could therefore begin to understand more completely the relation between the learning experiences provided by these various programmes and the changes which take place in their learners. Bloom *et al.* (1956:10) further explained that taxonomy is a classification of educational outcomes. The following section clarifies the Taxonomy of Bloom.

Bloom's Taxonomy was created in 1956 under the leadership of educational psychologist Dr. Benjamin Bloom (1913-1999). When Bloom gathered a group of assessment specialists together in the mid-20th century, his purpose was to provide the assessment community with a common language about learning goals which would facilitate communication across subject matter, persons and grades. According to Paul (1985) Bloom's taxonomy is "a method of classifying educational objectives, educational experiences, learning processes, and evaluation questions and problems" (Paul 1985:39).

Bloom's Taxonomy organized the goals of education into three domains. The cognitive domain relates to the intellectual part of education that is knowledge-based. The affective domain refers to the altitudinal changes that education can bring about. The psychomotor domain involves the development of mastery in motor skills. Bloom (1956) developed a six-tiered scheme to describe educational goals in cognitive domain which are: knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom *et al.* 1956: 62-187).

During the 1990s Anderson who was a former student of Bloom led a new assembly which met for the purpose of updating the taxonomy, hoping to add relevance for the

21st century learners and teachers. The following table includes the two primary existing taxonomies of cognition, the original one from Bloom (1965) and the Anderson and Krathwohl's (2001:31) version.

Table 3.2: Taxonomies of the Cognitive Domain

Bloom's Taxonomy	Anderson and Krathwohl's Taxonomy
Knowledge: Remembering or retrieving previously learned material	Remembering: Recognizing or recalling knowledge from memory. Remembering is when memory is used to produce definitions, facts, or lists, or recite or retrieve material
Comprehension: The ability to grasp or construct meaning from material	Understanding: Constructing meaning from different types of functions be they written or graphic messages activities like interpreting, exemplifying, classifying, summarizing, inferring, comparing and explaining
Application: The ability to use learned material, or to implement material in new and concrete situations	Applying: Carrying out or using a procedure through executing, or implementing
Analysis: The ability to break down or distinguish the parts of material into its components so that its organizational structure may be better understood	Analyzing: Breaking material or concepts into parts, determining how the parts relate or interrelate to one another or to an overall structure or purpose. Mental actions included in this function are differentiating, organizing, and attributing, as well as being able to distinguish between the components or parts
Synthesis: the ability to put parts together to form a coherent or unique new whole	Evaluating: Making judgements based on criteria and standards through checking and critiquing
Evaluation: the ability to judge, check and even critique the value of material for a given purpose	Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing. Creating requires users to put parts together in a new way or synthesize parts into something new and different. This process is the most difficult mental function in the new taxonomy

Anderson and Krathwohl (2001:31)

The taxonomy provides a framework for determining and clarifying learning objectives. Learning objectives involve both lower and higher order thinking skills as well as a mix of concrete and abstract knowledge. Figure 3.4 illustrates the lower and higher order

thinking skills of the original taxonomy of Bloom (1956) on the left hand side and the revised taxonomy of Anderson and Krathwohl (2001) on the right hand side.

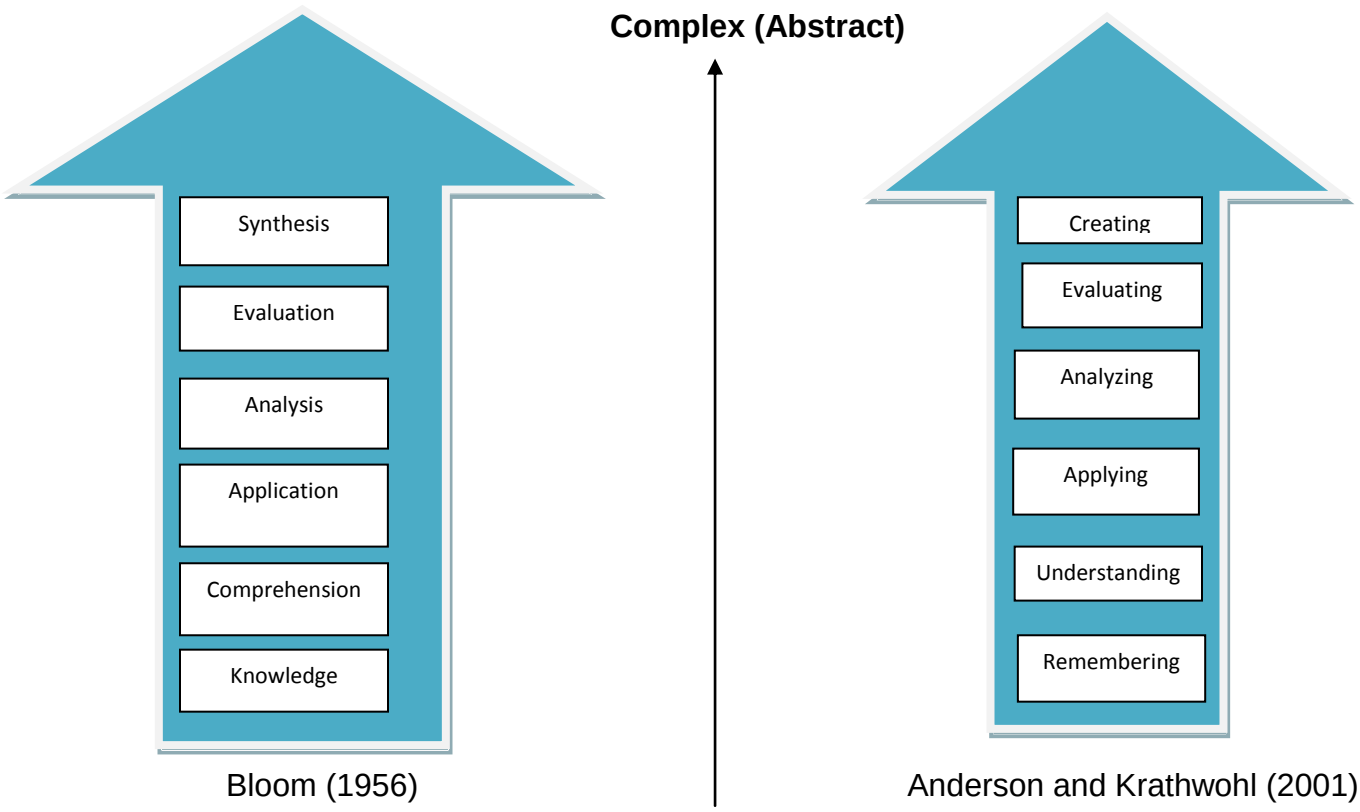

Figure 3.4: The taxonomies of the cognitive domain of Bloom versus Anderson and Krathwohl

Table 3.2 and Figure 3.4 show the changes in terminology between the two versions. The most obvious differences in Bloom's six major categories were changed from noun to verb forms (for example application to applying). The lowest level of the original knowledge was renamed and became remembering. Comprehension and synthesis were re-titled to understanding and creating. The top two levels were exchanged from Bloom's Taxonomy to Anderson and Krathwohl. Evaluation moved from the top to evaluating in the second from the top. Synthesis moved from second on top to the top as creating. The levels have been depicted as a stairway, guiding many teachers to

encourage their learners to ‘climb to a higher (level of) thought’. The lowest levels are: knowledge, comprehension and application. The higher levels are analysis, synthesis and evaluation. “The taxonomy is hierarchical; [in that] each level is subsumed by the higher levels. In other words, a learner functioning at the ‘application’ level has also mastered the material at the ‘knowledge’ and ‘comprehension’ levels” (UW Teaching Academy 2003).

One of the most frequent uses of the original Taxonomy of Bloom was to classify curricular objectives and test items in order to show the breadth or lack of breadth, of the objectives and items across the spectrum of categories (Krathwohl 2002:231). Assessment would therefore need to be articulated according to these dimensions of understanding, in addition to the levels of understanding proposed by Anderson and Krathwohl (2001:31). Apart from the different Mathematics areas, the CAPS describe four cognitive levels at which assessment has to be conducted. These levels are: Knowledge (25%), Routine Procedures (45%), Complex Procedures (20%) and Problem Solving (10%) (DBE 2011:157). Table 3.3 illustrates the cognitive levels of CAPS versus the cognitive levels of Anderson and Krathwohl.

Table 3.3: Cognitive levels: CAPS versus Anderson and Krathwohl

CAPS	Anderson and Krathwohl	Description of skills to be demonstrated
Knowledge 25%	Remembering	• Straight recall • Rounding of numbers • Direct use of formula • Use of Mathematical facts
Routine Procedures 45%	Understanding	• Perform well-known procedures • Simple applications and calculations • Derivation from given information • Identification and use of correct formula • Generally similar to those encountered in class
Complex Procedures 20%	Applying	• Problems involving complex calculations and higher order reasoning • Investigate axioms to generalize them into proofs for straight line geometry, congruence and similarity • No obvious route to solution • Making significant connections between different representations • Require conceptual understanding
Problem Solving 10%	Analyzing Evaluating Creating	• Unseen, non-routine problems • High order reasoning • Might require ability to break the problem down into its constituent parts

3.10 SUMMARY

This chapter provided a theoretical overview of assessment in education and also provided the reader with insight to understand the importance of assessment in the learning process. The different types of assessment were presented. Formative assessment is assessment for learning, while summative assessment is assessment of learning. There is an inextricable link between feedback and learners' performance. This chapter also indicated that the learners who receive regular feedback through assessment are better motivated to learn because they are actively involved in their own learning. The alignment of teaching, learning and assessment relies on a combination of strategies. The learning outcomes must be clearly defined and the assessment should assess the learners' achievement of the assessment standards. The taxonomies provided a framework for the alignment of teaching, learning and assessment. Formative assessment and feedback provided a way to work towards alignment with the involvement of the teacher and the learners.

The ANAs are largely formative assessments, as opposed to summative assessments, and are designed to draw on information gathered in the assessment process to identify learning needs and to adjust teaching.

The next chapter discusses the research methodology employed in this study.

CHAPTER 4

RESEARCH METHODOLOGY

4.1 INTRODUCTION

In Chapter 1 the researcher outlined the aim of this study namely to investigate the nature and extent of the influence of the ANA tests on the Mathematics pedagogy in a Grade 9 Mathematics classroom. In order to address the influence of the ANA tests on Mathematics pedagogy, relevant research data is necessary.

This chapter provides an overview of the research methodology used in this study. The chapter discusses population and sampling methods, defines and justifies the choice of data-collection techniques namely, semi-structured interviews of Grade 9 Mathematics teachers, focus-group interviews of Grade 9 Mathematics learners and the analysis of the Diagnostic Report of the ANA of the Department of Basic Education and the analysis of the Diagnostic Report of Teacher D; the analysis of the September 2014 test/examination of the sample schools and the ANA test written in September 2014 by Grade 9 Mathematics learners and the analysis of the results of the ANA 2014 test and the test/examination of learners of sample schools. This chapter discusses the data-analysis method and also clarifies how validity, reliability and trustworthiness were maintained in the research. It concludes with a brief discussion of ethical issues and the role of the researcher in the process.

4.2 RESEARCH DESIGN

All research studies begin with the development of a research design where the researcher proposes how he/she is planning to conduct the research. The research design can be seen as the strategic framework (Durrheim 1999:29; Durrheim 2006:34; Mouton 1996:108) of how the researcher is going to conduct the research. The research design is the overhead design (Punch 2005:142) of the step-by-step (Bless & Higson-Smith 1995:63) design of the empirical research (Punch 2006:48). According to

Creswell (2009:5) the research design is the design or proposal to do the research and this includes the intersection of philosophy, strategy of research and specific methods. Babbie and Mouton (2001:155) define the research design as a set of guidelines and instructions that the researcher uses to guide him/her towards the goal of his/her study.

Punch (1999:150) and Punch (2005:142) in Gray (2009:173) stated that the research design lies between the research questions and the data. The practical implication of this means that there is a link between the research questions and data (Punch 1999:150; Punch 2006:47) and demonstrates how the research questions are going to be addressed (Punch (2005) in Gray 2009:173). He argues that if the design occurs between the research questions and the data, the data are connected to the research questions, it also demonstrates the tools and methods to use in the answering of the questions; therefore, the design follows from the questions and also corresponds to the data. The research design serves as a bridge between the research questions and the execution or implementation of the research (Durrheim 1999:29; Durrheim 2006:35).

Flick (2009:128) agrees with these authors as reflected in his own words: “Research design is a plan for collecting and analyzing evidence that will enable the investigator to answer whatever questions he or she has posed. The design of an investigation touches almost all aspects of the research, from the minute details of data collection to the selection of the techniques of data analysis”.

Flick (2009:133) presents the factors that influence the research diagrammatically as displayed in Figure 4.1.

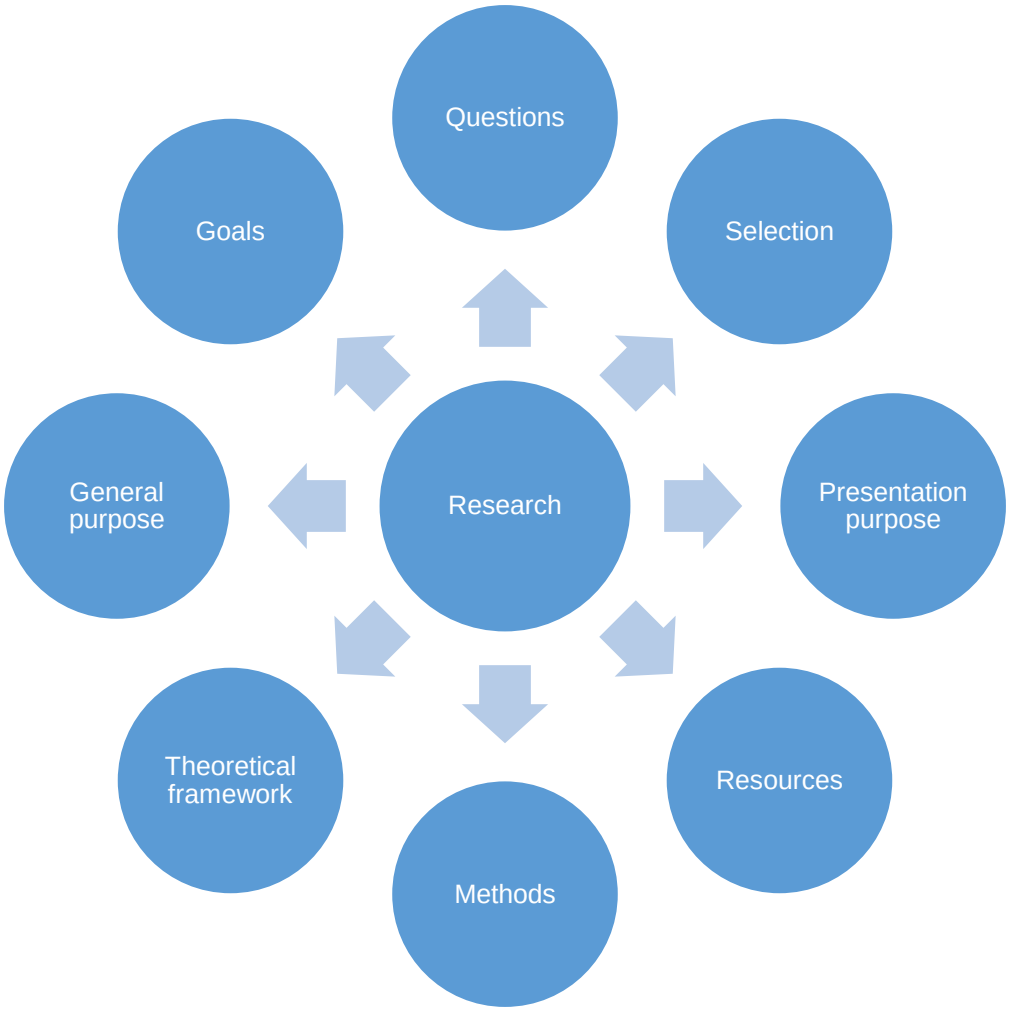

Figure 4.1: Components of qualitative research design

Adapted from Flick (2009:133)

The research design provides a design of the method to implement the research. This includes five main ideas: strategy, conceptual framework, who or what to study and the tools and methods to use to collect and analyze the empirical data (Punch 2006:48). There are five main questions in the research design:

- Which strategy to follow?
- Within which framework will the research be conducted?
- From whom the data will be collected?
- How will the data be collected?
- How will the data be analyzed?

According to the above questions Leedy and Omrod (2001:91) and Durrheim (2006:34) emphasize that the following five steps are included in the research design:

- Step 1: Define the research questions.
- Step 2: Research design.
- Step 3: Data collection.
- Step 4: Data analysis.
- Step 5: Recording of research report.

From the above it is clear that research requires preparation and design. In this study real life data form part of the research process, therefore there is a need for a theoretical framework and paradigm to sort and organize the unfolding relationship between data and events.

4.3 RESEARCH PARADIGM

According to Taylor, Kermode and Roberts (2007:5) a paradigm is a 'broad view or perspective of something'. Additionally, Weaver and Olson's (2006:460) definition of paradigm reveal how the research could be affected and guided by a certain paradigm by stating "paradigms are patterns of beliefs and practices that regulate inquiry within a discipline by providing lenses, frames and processes through which investigation is accomplished". Mertens (2005:7) argues that a paradigm is a way to see the world. Other authors see a paradigm as a lens or a theoretical framework (Henning *et al.* 2004:12-29) or a perspective (Creswell 2009:62) on the research study.

4.3.1 Components of the paradigm

Scotland (2012:9) believes that a paradigm consists of the following components: ontology, epistemology and methodology.

4.3.1.1 Ontology

Van Manen (2007:19) describes ontology as "Ontology established and shaped our understanding of being or what 'is' – *ti estin and hoti estin*. *Ti estin* is the question of whatness: what something is; *hoti estin* in the concern with thatness: that something is".

Denzin and Lincoln (2005:22) explain that ontology probes the following questions: What kind of being is the human being? What is the nature of reality? The researcher's ontological perspective is therefore "closely related to issues of how we decide to collect our research data…they are intimately linked to the basis upon which we think we know something to be true" (Oliver 2010:34). The nature of reality in this study is that teachers have to teach Grade 9 Mathematics learners.

4.3.1.2 Epistemology

Epistemology is the nature and type of knowledge (Cohen *et al.* 2007:7). According to Scotland (2012:9) epistemology is how you create, gain and communicate knowledge. Denzin and Lincoln (2005:22; 2012:12) explain that epistemology asks the following question: What is the nature of the relationship between the researcher and the known? Epistemology concerns the philosophical study of knowledge and "the grounds upon which we believe something to be true" (Oliver 2010:35) – in other words, "what counts as educational knowledge and how is it obtained"? (Sharp 2009:5). The study of knowledge will be obtained through a literature study and empirical research.

4.3.1.3 Methodology

Methodology refers to the strategic plan of action which illustrates the choice of research technique. Babbie (2013:555) views methodology as the science of inventing or procedures for scientific research. According to Scotland (2012:9) methodology probes the following questions: why, what, from where, when and how will data be collected and analyzed? Denzin and Lincoln (2005:22; 2011:12) explain methodology with the following questions: How do we transfer knowledge to the world? How can we acquire knowledge? In this study, knowledge was acquired through a qualitative research study where data is obtained through semi-structured interviews and a document analysis.

In the following section, the researcher discusses the interpretivist paradigm.

4.3.2 Interpretivist paradigm

The ontological position of interpretivism is realism (Scotland 2012:11). Realism means the ability to see the world through more than one theoretical frame or paradigm (De Vos 2005:363). According to Guba and Lincoln (1994:105-117) realism is subjective and differs from person to person.

The interpretivist paradigm is one of subjectivity which is based on the real world phenomena (Scotland 2012:11). In terms of epistemology interpretation is closely linked to constructivism (Gray 2009:21). Knowledge and reality are constructed in the interaction between people and their world, and develop into a social context (Crotty (1998) in Scotland 2012:12). Therefore Cohen *et al.* (2007:19) suggest that the social world can only be explained from how an individual sees the world. An interpretivist paradigm is thus all about understanding the phenomena from the perspective of the individual's historical and cultural world (Creswell 2009:8). Examples of methodology are case studies (in-depth study of events) (Punch 2005:142), phenomenology (the study of human experience in the real world) (Gray 2009:23) and ethnography (research that focuses on the culture of a group of people) (Leedy & Omrod 2001:151).

Interpretivist paradigm provides an understanding of behaviour, declare actions from the participants' perspective and do not dominate the participants (Scotland 2012:12). Examples are open-ended interviews, open-ended questionnaires and open-ended observations. These examples generate qualitative data.

Since the aim of this study is to investigate the experience and perspective of Grade 9 Mathematics teachers and learners of the ANA tests, this study will be conducted within an interpretivist paradigm. To answer the research questions as mentioned in Chapter 1, the researcher chose a qualitative research approach within an interpretivist research paradigm (Denzin & Lincoln 2005:500). A qualitative research approach was used in this study because the investigation focused on an understanding of a particular phenomenon, namely teachers and learners' perspective of the ANA tests.

4.4 THE AIM OF THE RESEARCH STUDY

The aim of this study was formulated from the overarching research question namely to investigate the nature and extent of the influence of the ANA on the Mathematics pedagogy in a Grade 9 Mathematics classroom.

The following sub-questions derived from the main research question and were formulated in order to guide the study towards addressing the research problem:

- Does the ANA have an influence on the teaching of Mathematics in a Grade 9 Mathematics classroom?
- Does the ANA have an influence on the learning of Mathematics in a Grade 9 Mathematics classroom?
- Does the ANA have an influence on assessment in a Grade 9 Mathematics classroom?
- Is the implementation of the ANA aligned with the intention of the designers of the ANA 'project'?

The findings to these questions enabled the researcher to identify aspects that need to be considered in teaching, learning and assessment of the ANA in Grade 9 Mathematics classrooms.

4.5 RESEARCH APPROACH

In Chapters 2 and 3 a literature study was conducted to investigate what the teaching, learning and assessment of Mathematics entail. From that understanding the researcher was able to construct a theoretical framework regarding the teaching, learning and assessment of Mathematics. The nature of the problem statement within the theoretical framework and the search for really understanding the phenomenon, naturally led to a qualitative approach within an interpretivist paradigm as stated above.

According to Punch (2005:236) this strengthens the need to understand the characteristics of qualitative research. The following section discusses the basic characteristics of qualitative research.

4.5.1 Characteristics of qualitative research

4.5.1.1 Natural setting

Qualitative research takes place in the natural world (Marshall & Rossman 2006:2). Qualitative researchers collect data from the real world (Gray 2009:166) thus, from the place where the participants experience the problem (Creswell 2009:175). The natural setting in this research study is the Mathematics teacher in his/her respective school.

4.5.1.2 Researcher as the primary instrument

According to Merriam (2002:5) and Punch (2006:52) the researcher is the primary instrument in the data collection and data analysis processes. Qualitative researchers are often described as the research instrument because the biggest part of the research depends on the personal involvement (interviews) in the world (setting) (Leedy & Omrod 2001:47). Creswell (2009:175) reports that qualitative researchers collect the data through the examination of documents or through interviews with the participants. He further assumes that a researcher may use a protocol (an instrument for gathering data), but the researcher is mainly the person who gathers the data.

In order to reach coherence between the chosen research paradigm and the aim of this study, as well as to get answers on the research questions, the researcher collected qualitative data which includes qualitative variables (cf. 4.7.3). According to Leedy and Omrod (2001:102) verbal data (interviews, documents and field notes) and non-verbal data (sketches, photos and videos) can be collected. In this research study the researcher is the primary instrument.

4.5.1.3 Reflexivity of the researcher

Flick (2009:16) states that the subjectivity of the researcher and the participants is part of the research process. Reflexivity is the relationship between the researcher and the social world (Denscombe 2007:333). According to Denscombe (2007:333):

"A researcher can never stand outside the social world they are studying in order to gain some vantage point from which to view things from a perspective which is not contaminated by contact with that social world. Inevitably, the sense we make of the social world and the meaning we give to events and situations are shaped by our experience as social beings and the legacy of the values, norms and concepts we have assimilated during our lifetime".

4.6 POPULATION AND SAMPLING

4.6.1 Population

Population is defined by Neuman (2006:224) as the abstract idea of a large group of cases from which a researcher draws a sample and from which results are generalized. According to Creswell and Plano Clark (2007:112) a population is described as a group of individuals who possess specific characteristics and from whom a sample is drawn to determine the parameters or characteristics. The population of this study consisted of schools teaching Grade 9 Mathematics in the General Education and Training (GET) phase in the Free State Province.

4.6.2 Sampling

Sampling refers to the process of selecting a sample representative of a population that the researcher uses to make assumptions. Miles and Huberman (1994:27) believe that you cannot study everyone everywhere doing everything.

According to Leedy and Omrod (2005:199) there are two major classes of sampling methods, namely probability sampling and non-probability sampling. Non-probability sampling includes random sampling, purposive sampling, snowball or chain referral sampling and quota sampling (De Vos 2005:201).

For the purpose of this study, the researcher used non-probability sampling. Purposeful sampling was used to select six schools in the Motheo-district (unfortunately one of the schools withdrew due to the fact that there were too many researchers at their school at the time of the research which interrupted the school's programme). Therefore the sample consists of five schools. The sampling decisions were made specifically for the

explicit purpose of obtaining the best possible source of information to respond to the research questions. In other words, the sample was hand-picked for this research. This is consistent with Cohen *et al.* (2010:115) who define purposive sampling as a sampling approach in which participants are selected because of some defining characteristics that make them the holders of data needed for the study. The sampling decisions were made specifically for the explicit purpose of obtaining the best possible source of information to respond to the research questions.

4.7 DATA COLLECTION INSTRUMENTS

This section focuses on a discussion of the instruments used to collect data. Semi-structured interviews with teachers, focus-group interviews with learners and document analyses were used for this research study.

4.7.1 Semi-structured interviews

The semi-structured interview is a person-to-person conversation with the objective of exploring the research topic with the research participant (Watts & Ebbutt 1987:25-34; Wengraf 2001:5-10). It is therefore important to discuss the advantages and disadvantages of interviews.

According to Bryman in Denscombe (1998:163-192) interviews are used to collect data for research purposes when:

- The focus on the interviewee's point of view is important.
- A deeper understanding of and insight into the phenomenon is needed.
- Flexibility is important for the research process.
- The focus on what people say and how they say it is significant for the inquiry.

According to Bryman in Denscombe (1998:163-192), interviews have both advantages and disadvantages. The advantages include the following:

- Interviews aid the memory of the researcher when properly transcribed.
- The data can be thoroughly examined.
- Repeated analysis of data is possible.

- Data can be scrutinized by other researchers.
- Interviews are useful when the participants cannot be observed directly.
- Interviews generate historical information.
- Interviews permit the researcher to control the pace and style of questioning.

Other authors highlighted the importance of being in control as another advantage of interviews (Denscombe 1998:163-192), while others pointed out that an interview could limit the depth of information the participant is able to give (Wengraf 2001:5).

According to Bryman in Denscombe (1998:163-192) the disadvantages of interviews are the following:

- Indirect and unnecessary information could be given.
- Interviews take place at designated places that are not natural settings.
- The researcher's presence could trigger bias.
- People are not always the same in articulating their views clearly.
- Interviews are time consuming.

To prevent the disadvantages mentioned above, the researcher guided the participants with direct questions and sub-questions in order to prevent unnecessary information (see Appendix A and B). The interviews took place on the school grounds, in classrooms, boardrooms and conference rooms in the natural setting where the participants felt secure. Before the interviews were conducted, the researcher informed the participants that the interviews were limited to one hour. During the interviews the researcher used effective interview techniques, such as avoiding yes/no and leading questions, appropriate body languages and kept her personal opinions to herself.

4.7.2 Focus-group interviews

A focus-group as a research instrument involves more than one participant per data collection session (Wilkinson 2004:271-295). Kitzinger (1995:299-302) argues the value of focus-group interview as:

> "the idea behind the focus group is that group processes can help to explore and clarify their views in ways that would be less easily accessible in a one-to-one interview…when group dynamics work well the participants work alongside the researcher, taking the research in new and often unexpected directions".

Babbie (2004:302) defined that "a focus group is a group of 12-15 people brought together in a room to engage in a guided discussion about the same topic". The focus-group interview is used in a research inquiry because it has the following known advantages (Babbie 2004:303):

- It is a socially oriented research technique capturing real-life data in a social environment.
- It is flexible.
- It has high face validity.
- It produces speedy results.
- The costs are low.

However, according to Babbie (2004:303) focus-group interviews have the following disadvantages:

- The researcher has less control than with individual interviews.
- Data are difficult to analyze.
- Moderators require special skills.
- Differences between groups can be a problem.
- The interview situation must be conductive to discussion.
- It is difficult to constitute groups.

To ensure that these disadvantages did not influence the research, the researcher limited the focus group to six to eight learners, purposefully selected from a merit academic list (two above average learners, three average learners and two below average learners). All focus-group learners were Grade 9 learners in Mathematics in 2014. To guide the discussion, the researcher used an interview guide (see Appendix A and B).

4.7.3 Document analysis

Qualitative studies often explore variables other than one specific influence that might have affected a sample group outcome (Johnson & Kuby 2011:8-24). Qualitative methods allow the researcher to focus on the process of how something happens rather than on just the results. Qualitative analysis considers the multiple truths and perception of individuals and highlights the importance of looking at variables in the natural setting they are found. Thus, relation between variables is important in the conclusion of qualitative studies (Johnson & Kuby 2011:8-24).

Qualitative variables also known as categorical variables are variables that are not numerical and describe data that fits into categories (Johanson & Kuby 2011:8-24). In this research the aim was to investigate the nature and extent of the influence of the ANA on the Mathematical pedagogy in a Grade 9 Mathematics classroom. The researcher therefore analyzed the Diagnostic Report of Teacher D (only Teacher D presented their school's Diagnostic Report) and the Diagnostic Report of the DBE of the Mathematics ANA test written in September 2014; an analysis of the questions in the ANA test and the questions of the Mathematics test/examination written in September 2014 of the five sample schools according to Bloom's adapted taxonomy; an analysis of the results of the ANA 2014 test and the results of the September 2014 test/examination of the five sample schools. In the document analysis the researcher classified the different content areas (cf. 5.6.1) and the cognitive levels of the CAPS document (cf. 5.6.2) as qualitative variables. Bar graphs are used to display qualitative data and to observe if there is an association between the qualitative variables.

4.8 DATA ANALYSIS

Data analysis is the process of making sense with the data which involves interpreting, consolidating and reducing what people have said and what the researcher has seen and read in order to understand and make meaning out of the process (Mpya 2007:15). It is a complex process that involves moving back and forth between concrete pieces of data and abstract concepts, between inductive and deductive reasoning, between description and interpretation (Mpya 2007:15). According to Mouton (2001:108) the aim

of data analysis is to understand the components of data and determine the relationships between variables, patterns and themes. Data analysis results in interpretation, which involves synthesizing data into a coherent whole. Burns' opinion (2000:430) of the purpose of data analysis is to give meaning to the data and this can be achieved by grouping the data systematically. Patton (2002:432) defines data analysis as "reducing the volume of raw information, sifting significant patterns and constructing a framework for communicating the essence of what the data reveals". According to De Vos (2005:333) data analysis is the process to give order, structure and meaning to the data collected.

In this study the data analysis was done on three sets of data. The first set consisted of the results from the Grade 9 teachers' semi-structured interviews. The second set was the focus-group interviews with the Grade 9 Mathematics learners. These interviews were transcribed verbatim and analyzed using qualitative descriptive content analysis, including the following processes: coding, finding, categorizing, clustering, and identifying patterns and meaning. Each transcription was then analyzed to generate categories, themes and patterns. During this step, data were coded to identify keywords. Finally the data were categorized into themes and subthemes and a report was compiled. The third set consisted of the analysis of the Diagnostic Report of the ANA 2014 test of the DBE compared to the Diagnostic Report of Teacher D; the analysis of the September 2014 Mathematics test/examination of the five sample schools as well as the analysis of the Mathematics ANA 2014 test written in September 2014 and the analysis of the ANA 2014 results and the results of the test/examination of the sample schools written in September 2014.

4.9 ETHICAL CONSIDERATIONS

This section focuses on a discussion of ethical issues. Research ethics are primarily the interaction between the researcher and the participants that were studied. Flick (2009:36) states that an ethical code is formulated to regulate the relationship between the researcher and the participants. For this reason it is important that there is trust between the researcher and the participants (Mack *et al*. 2005:8).

As mentioned in Chapter 1 (cf. 1.6) the researcher obtained ethical clearance from the clearance office of the Faculty of Education at the University of the Free State. The ethical clearance certificate containing the reference number (UFS-EDU-2014-036) is attached as Appendix H.

The next section focuses on the principles of ethical issues.

4.9.1 Informed consent

Ethical guidelines emphasize the importance of informed consent (Creswell 2008:238; Flick 2009:37; Leedy & Omrod 2001:107; Silverman 2000:201). The participants have to give informed consent to participate in the research study. In this study, the researcher informed the principals, teachers and learners of the five sample schools about all aspects of the research study.

4.9.2 Confidentiality

According to Wiersma and Jurs (2009:458) confidentiality refers to the secrecy or the act of not disclosing the identity of participants in research. In this study the privacy of the participants was honoured and necessary precautionary measures were taken not to disclose the identity of the participants. Thus, participants in this study were given the assurance that all data will be treated confidential and will only be used for academic purposes of this research study.

4.9.3 Anonymity

The identity of participants must be ensured (Marshall & Rossman 2011:48). To ensure the anonymity of the participants in this study, the researcher referred to the five sample schools as school A, B, C, D and E, to the teachers as teacher A, B, C, D and E and to focus-group learners as A, B, C, D and E.

4.10 DATA VERIFICATION

In this study, qualitative data were collected to obtain answers to the research questions. According to Leedy and Omrod (2001:103) research can only be valuable if

the researcher draws significant and defensible conclusions from the data. For this reason the verification of qualitative research data is crucial (Denscombe 2007:296).

Validity and reliability of research are crucial in research regardless of the disciplines and methods employed (Sherman & Webb 1988:861). Regarding the validity of qualitative research, Strydom *et al.* (2002:35) quotes Marshall and Rossman (1995) as follows:

> "…all research must respond to canons that stand as criteria against evaluated".

This implies that one has to ask the following questions:

- How credible are the particular findings? By what criteria can we judge them?
- How transferable and applicable are these findings to another setting or group of people?
- How can we be reasonably sure that the findings would be replicated if the study was conducted with the same participants in the same context?
- How can we be sure that the findings are reflective of the subjects and the inquiry itself, rather than on creation of the researcher's biases or prejudices (Strydom *et al.* 2002:351)?

According to Strydom *et al.* (2002:351), Lincoln and Guba (1985) refer to these questions as establishing the 'truth value' of the study, which are its applicability, consistency and neutrality. Lincoln and Guba in Strydom *et al.* (2002:351) propose constructs that are more suitable to the qualitative paradigm than the conventional positivist paradigm – internal validity, external validity, reliability and objectivity. These four constructs are:

- Transferability is an alternative to external validity. Freebody (2003:77) explains that external validity involves the extent to which independent research working in the same similar content would obtain consistent results. Strydom *et al.*

(2002:352) notes that transferability or generalization of a qualitative study may be problematic and is seen as a weakness. It is not the purpose to transfer the findings of this research to other settings. According to Krefting in White (2005:206) transferability is also labelled 'fittingness'. This refers to the probability that the findings will have meaning to others in similar situations. The researcher has to provide the information that potential applicants need to make a decision on transferability. To evaluate transferability the researcher provided a dense description of the research process by giving the finer details of all aspects observed during this study.

- Dependability is the alternative for reliability. Positivist notions of reliability assume an unchanging universe where inquiry could, quite logically, be replicated. A qualitative study has a natural setting as its focus; therefore it has to take into account that "the social world is always being constructed" (Strydom *et al.* 2002:352). To assess dependability in this research, the researcher conducted a dependability audit, checking if all processes were handled properly by giving a dense description of each process engaged.
- Confirmability captures the traditional concept of objectivity. In qualitative research the emphasis is on the data and the question to be answered is: Does the data help to confirm the general findings and lead to the implications? (Strydom *et al.* 2002:352). Leaving an audit trail, the researcher illustrated as clearly as possible the evidence and thought process that led to the conclusions. In this research study, the researcher tested confirmability by reflecting on the research process together with the participants by way of open conversations.

During the data-gathering process of this study the five schools under investigation represented the multiple realities that are present in a naturalistic setting.

The biographical information of the teachers (see Table 5.1) of the schools was described; during the data analysis the complexities came to the fore and triangulation was used as a form of verification of the data. The literature study provided in Chapter 2 and 3 provided the questions used in the interview process.

4.11 TRIANGULATION OF DATA

Data triangulation means to support the findings of the empirical research by using data from different sources (Denscombe 1998:131). Triangulation was used in this study to elucidate the research process – as Neuman (2006:218) states, studying a phenomenon from different angles provides a clearer understanding and perspective.

De Vos (2005:361) believes that triangulation is the process of collecting material in as many ways and from as many diverse sources as possible. In this research study, the data were triangulated from the literature, semi-structured interviews, focus-group interviews and the data obtained from the analysis of the Diagnostic Report of the ANA 2014 test of the DBE and the analysis of the Diagnostic Report of Teacher D; the analysis of the September 2014 test/examination of the sample schools and the ANA test written in September 2014 by Grade 9 Mathematics learners and the analysis of the results of the ANA 2014 test and the results of the test/examination of the sample schools written in September 2014.

4.12 ROLE OF THE RESEARCHER

The researcher was the interviewer and tried to avoid imposing her ideas upon the participants. This ensured that the interviews captured the real facts in the words and language of the participants. All the ethical matters pertaining to the study were respected. Firstly, all authors whose work was referred to were acknowledged. Care was taken that the participants should not be disadvantaged nor the researcher privileged. The anonymity of the participants was guaranteed.

4.13 SUMMARY

This study dealt with the perceptions of teachers and learners on the ANA test in a Grade 9 Mathematics classroom. This chapter provided an overview of the research design used in this study from an interpretivist, qualitative paradigm. The data collection instruments used in this study were semi-structured interviews with five teachers from five sample schools and focus-group interviews with learners of the five sample schools

in the Motheo-district. In this study, the researcher used a thematic analytical approach, since she identified themes in the gathering of the data.

A discussion on data analysis and ethical considerations also formed part of this chapter. The next chapter focuses on the presentation of the research data of this study.

CHAPTER 5

PRESENTATION OF THE RESEARCH FINDINGS

…teachers' own personal reflections in relation to their (private) lives and (professional) work may help us gain valuable insight into what it means to be a teacher in a specific cultural, social and historical context.

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5.1 INTRODUCTION

As indicated in Chapter 1 (cf. 1.3), this research study aimed to investigate the nature and extent of the influence of the ANA on the Mathematics pedagogy in a Grade 9 Mathematics classroom. For this reason the following objectives were also addressed: to explore and describe to what extent the ANA has influenced the teaching of Mathematics in a Grade 9 Mathematics classroom; examine the influence that the ANA has on the learning of Mathematics in a Grade 9 Mathematics classroom; explore if the ANA has an influence on assessment in a Grade 9 Mathematics classroom; explore if the implementation of the ANA is in alignment with the intention of the designers of the ANA 'project' and to formulate recommendations and future research possibilities. In Chapter 4 the research design and research methods of this study were discussed. In this chapter the data generated from the individual interviews with the five teachers and the five focus-group interviews with the learners; an analysis of the Diagnostic Report of Teacher D and the Diagnostic Report of the DBE of tests written in September 2014; an analysis of the September 2014 test/examination of the five sample schools and the ANA 2014 test; the analysis of the results of the five sample schools and the ANA 2014 test are also presented in this chapter.

Biographical data of the participants were given to create a clearer picture of their situations to place their responses in context.

5.2 DATA COLLECTION TECHNIQUES

As indicated in Chapter 4 (cf. 4.7.1; 4.7.2) qualitative data were collected in the form of semi-structured interviews with five teachers and five focus-groups of the five sample schools. Originally six schools were selected for the sample, but unfortunately, one of the schools did not give the researcher permission to do the research at the school due to the fact that there were too many other researchers at the time conducting research at that school. Therefore only five schools were part of this research study. The researcher used an interview guide (see Appendix A and B) to interview participants. The questions in the interview guide revolved around the main purpose of this study namely: "To what extent the ANA has an influence on teaching, learning and assessment in a Grade 9 Mathematics classroom".

The interviews took place from 11 August 2014 to 14 September 2014 and were carried out in classrooms, a boardroom and conference room on the school grounds. Before the interviews the researcher contacted the principals to ask if they were willing to participate in the research study (see Appendix D). The researcher followed the legal codes and ethical principles for sound research practice. A written information sheet, explaining the purpose of the study, was given to participants. The informed consent was obtained from teachers (see Appendix E) and learners (see Appendix F) involved in the research study. Interviews with the teachers and focus-groups took place after school hours and some during school hours (hall period and free period of teachers/learners). When convenient to the teachers and the focus-groups, appointments were made to conduct the interviews. The interviews were recorded, with the participants' approval, using a digital recorder.

5.3 BIOGRAPHICAL DATA OF PARTICIPANTS

Teachers participating in the study completed a short questionnaire (see Appendix C), in which they provided their biographical details. They also signed a declaration form of voluntary participation (see Appendix E). The following abbreviations were used throughout the presentation, analysis and interpretation of data of schools (School A, B,

C, D and E), teachers (A, B, C, D and E) and focus-groups (A, B, C, D and E). The following table shows the biographical data of the teachers.

Table 5.1: Biographical data of teachers

	Teacher A	**Teacher B**	**Teacher C**	**Teacher D**	**Teacher E**
Male/Female	Female	Female	Male	Female	Female
Age	32	60	33	32	51
Years' experience teaching Grade 9 Mathematics	10 years	39 years	2 years	2 years	27 years
Years' experience in the ANA	2 years	4 years	2 years	1 year	5 years
Qualification	NGOS; M.Sc. (Mathematics Statistics)	B.A. H.O.D	B.Ed. FET (Natural Sciences)	B. Ed. FET	M.A. (Afrikaans) with Mathematics 3 H.O.D.
Highest qualification in Mathematics	Mathematics 3	Mathematics 2	Mathematics 1	Mathematics 1	Mathematics 3

In agreement with the focus of the research, Grade 9 teachers and Grade 9 learners of the five sample schools were included in this study. Four female teachers and one male teacher participated in this study. All of the teachers were Afrikaans speaking with the exception of one English speaking teacher. From the five teachers that were interviewed, two of them were Heads of the Department (HODs) and the rest of the teachers were post-level 1 teachers. The Grade 9 teacher of School C, who was responsible for the Grade 9s of 2014, resigned at the end of 2014 and the researcher

interviewed the HOD of School C. From Table 5.1 it is clear that the age of the teachers show that three of the teachers were between the ages of 30 and 40, two of them between the ages of 50 and 61. The teachers' teaching experience varied from 2 to 39 years. It can therefore be said that some teachers had more experience than others. All educators were selected on the basis that they were qualified to teach Mathematics and had at least one year of 'ANA experience'. The amount of experience in teaching ANA varied from one to five years, but it must be noted that the ANA was implemented in 2011 and that it is relatively new to all teachers teaching the ANA. The focus-groups consisted of six to seven learners. The researcher asked the Grade 9 teachers to select the learners from a merit list. Two learners were selected above average, three averaged learners and two learners below average.

The following table shows the biographical data of the Grade 9 Mathematics focus-groups.

Table 5.2: Biographical data of the learners in focus-groups

Focus-group A	**Focus-group B**	**Focus-group C**	**Focus-group D**	**Focus-group E**
6 Boys	2 Boys 5 Girls	2 boys 4 girls	3 boys 4 girls	3 boys 4 girls
4 Afrikaans speaking 2 English speaking	All Afrikaans speaking	All English speaking	All Afrikaans speaking	All Afrikaans speaking

Before the interviews with the focus-groups were conducted the researcher took the declaration forms to the school so that the parents of the learners can give the learners permission to take part in the research (see Appendix F). Two of the selected focus-group interviews consisted of six learners for the reason that their parents did not give

them permission to take part in the research. The rest of the focus-groups consisted of seven learners.

5.4 WORK ENVIRONMENT OF THE PARTICIPANTS

5.4.1 School A

School A was founded in 1855, thus it is a very old school. This historical school is situated in Bloemfontein and is a parallel medium boys' school (Afrikaans and English speaking learners are taught in separate classes, each receiving instruction through the medium they select). Learners come from Bloemfontein and all over South Africa. The school provides boarding and thus accommodates learners from outside Bloemfontein. The school is situated in one of the fine neighbourhoods in Bloemfontein. This school consists of a Pre-primary, Primary and Secondary school. The Secondary and Primary school were separated in 1950. The school grounds were clean and neat. The gardens surrounding the main building of this school were beautiful. Extramural activities offered to the learners are: rugby, cricket, hockey, tennis, golf, soccer, etcetera. There are more than one hockey, cricket and rugby field. Teacher A's Mathematics classroom was well organized, with single tables standing in rows. The classroom was decorated with photos of learners and there were posters against the walls and on the notice boards. Some posters were related to Mathematics, while others were verses from the Bible. The interview with Teacher A took place during school hours in a free period (30 minutes) of the teacher. The interview with Focus-group A took place in a hall period (30 minutes) during school hours.

5.4.2 School B

School B was founded in 1956. The school is located in one of the fine neighbourhoods in Bloemfontein. The LoLT (Language of Learning and Teaching) of the school is Afrikaans. Learners come from all over Bloemfontein. There are no boarding facilities. The school grounds were neat and clean and the garden surrounding the main building was orderly and beautiful. The school offers a wide range of extramural activities to learners with more than one hockey, rugby and cricket field. The interview with Teacher B and Focus-group B took place in the conference room (situated next to the

headmaster's office) of the school during school hours (learners had a free period). The duration of both interviews was 30 minutes.

5.4.3 School C

School C was established in 1989, thus it is a relatively new school. School C is situated in a Bloemfontein Township. All learners are black and the LoLT of the school is English. Learners come from the outlying townships to attend this school. There are no boarding facilities. The school offers soccer and netball as extramural activities. There is only one soccer field. There are a few trees in front of the office. The school grounds were clean and neat. The interviews with the teacher and focus-group of School C took place in the board room (duration of the interview with the teacher and focus-group were respectively 40 and 45 minutes). The interviews took place on a Friday at 12h00 and this was also the time of day when learners and teachers cleaned the classrooms. The interviews were disrupted by constant distractions: people moving in and out of the board room, screaming outside and music playing.

5.4.4 School D

School was founded in 1905 and is a relatively old school. School D is located in one of the fine neighbourhoods of Bloemfontein and learners and teachers speak Afrikaans. The reception area of this school was beautifully decorated. The garden that encircles the main building was beautiful and neatly maintained. The school offers more than one extramural activity. There are more than one rugby field, hockey field, cricket field, netball court and tennis court. The interviews took place in a courtyard outside the staffroom. During the interviews it was very noisy due to the fact that the interview took place during a hall period where the school leaders were presented to the rest of the school. Music could be heard during the interviews. The duration of the interview with the teacher and focus-group were 25 and 45 minutes, respectively.

5.4.5 School E

School E once consisted of a Primary and Secondary school. Originally the school operated as both Primary and Secondary school. Since1966 it was separated and it now operates as two individual schools. School E is situated in one of the fine areas in

Bloemfontein and learners speak Afrikaans. The garden in front of the main building was beautiful. School E offers more than one extramural activities for example: rugby, cricket, hockey, tennis, netball, etcetera. There are more than one rugby and hockey field. The interviews took place after school hours in one of the teacher's classrooms. Teacher E's Mathematics classroom was well organized, with single tables standing in rows. The teacher's desk was stacked with portfolios and writing books of the learners, when asked about this Teacher E replied that she had inspection from her learner facilitator and therefore her classroom was packed with learners' portfolios. The classroom was decorated with posters against the walls. The posters on the walls were related to Mathematics. The duration of the interview with the teacher and focus-group were 45 and 35 minutes, respectively.

5.5 DISCUSSION OF EMERGING THEMES

In this chapter the data of five teachers and five focus-groups are presented and a comprehensive description is given how they experienced the ANA test. The discussion answered the main research question: "Does the ANA have an influence on the teaching, learning and assessment of Mathematics in a Grade 9 classroom"? The study responded to the following research questions in order to achieve its aim and objectives:

- Does the ANA have an influence on the teaching of Mathematics in a Grade 9 Mathematics classroom?
- Does the ANA have an influence on the learning of Mathematics in a Grade 9 Mathematics classroom?
- Does the ANA have an influence on assessment in a Grade 9 Mathematics classroom?
- Is the implementation of the ANA aligned with the intention of the designers of the ANA 'project'?
- To formulate recommendations and future research possibilities.

In the reporting of the data the researcher made an extreme decision to represent the data verbatim in the interest of authentic and academic honesty. Some of the quotes

were not grammatically correct, but were real to the response of the participants. In the analysis of data the researcher referred to the comments of the participants. For example Teacher A, line 62 and Focus-group B, line 70, which referred respectively to Teacher A, interview transcript, line 62 and Focus-group B, line 70 interview transcript. The researcher translated the verbatim data from Afrikaans to English (brackets) seeing that this report is written in English.

From the analysis of the semi-structured interviews with the teachers and learners the following themes emerged: teaching, learning and assessment. Each of the themes had a variety of sub-themes.

5.5.1 Theme 1: Teaching

5.5.1.1 Preparation in the classroom

The sub-theme did not emerge in the literature study and it was therefore necessary to expand the literature study to include this specific topic.

Preparation for teaching was identified as one of the most important aspects of effective teaching. The degree of preparation will usually determine whether or not the lesson has achieved its purpose (Behr 1997:89). Behr (1997:89) further pointed out that the unprepared or poorly prepared lesson can always be recognized by some or all of the following features: disorderly presentation of information; subject matter that is either incorrect or incomplete; the absence of any or adequate teaching aids or illustrative materials. In the MAKER framework of Fenstermacher and Soltis (cf. 2.4) Method is inter alia how to plan lessons. It can therefore be stated emphatically that teachers and how they prepare (plan) their lessons are an influential educative force in the lives of learners and that they have a role to play in shaping the learners' future.

The Senior Phase Mathematics Curriculum and Assessment Policy Statement (CAPS) provides teachers with a definition of Mathematics, specific aims, specific skills, focus of content areas, weighting of content areas and content specifications. It also provides teachers with content clarification which includes teaching guidelines, suggested sequencing of topics per term and suggested pacing of topics over the year. Each content area was broken down into topics. This section also provides the teacher with

guidelines in connection with content areas, concepts and skills, clarification notes with teaching guidelines and the duration of time allocated per topic in hours (DBE 2011:8-37, 118-154).

At all schools it was evident that teachers prepared their Grade 9 lessons according to the syllabus prescribed by the DBE.

> ‘Sillabus gedoen soos ek altyd gedoen het’ (did the syllabus as I usually do) (Teacher A,line 5).

> ‘Ek volg die sillabus’ (I follow the syllabus) (Teacher B, line 256).

Although most teachers interviewed prepared their Grade 9 Mathematic learners according to the syllabus prescribed by the DBE, one teacher (Teacher C) highlighted that he prepared his learners according to the ANA test. He explained

> ‘According to work schedule…based on preparation of ANA’ (Teacher C, line 21).

In the Annual National Assessment Guidelines the DBE outlines the minimum curriculum content that must be covered by all learners prior to the writing of the ANA test. The Assessment Guidelines are arranged in columns containing: content area; topics; concepts and skills and descriptive statements of what will be assessed in the ANA test. The DBE expects that teachers use the Assessment Guidelines for their teaching and assessment schedule (DBE 2015a:1-8). The teachers interviewed prepared the learners to write the ANA according to the guidelines of the DBE. Although the Assessment Guidelines of the ANA states the content, Teacher E was of the opinion that the average learner cannot handle the amount of work.

> ‘want as jou volume soos nou vir die September toets kleiner is, jou kind is meer voorbereid om die kleiner volume te hanteer’ (if the volume is less than in the September test, the child is more prepared to handle the smaller volume) (Teacher E, line 39).

Teacher E also experienced uncertainty because the schedule for the preparation according to the ANA test is not defined.

> ‘hoe wyd gaan dit gevra word?’ (how broad is it going to be asked) (Teacher E, line 6).

Exemplar papers and the previous years' papers of the ANA (2011 to 2013) are available for learners and teachers on the DBE's website. For the preparation of the learners in terms of preparing them for the ANA, all teachers (Teacher A to E) interviewed, gave the previous years' papers (2012 and 2013) of the ANA to the learners to prepare them for the ANA test in 2014.

> 'van die vorige vraestelle as 'n hersiening' (previous papers as revision) (Teacher A, line 129).
>
> 'Ons het 2013 deurgewerk' (we worked through 2013) (Teacher B, line 9).
>
> 'hulle het gesê hierso is vraestelle ons kan daar deurwerk' (they said here are papers and we can work through them) (Focus-group B, line 83).
>
> 'Ons het vraestelle gekry' (we received papers) (Focus-group D, line 73).
>
> 'He gave us 2012 and 2013' (Focus-group C, line 29).
>
> 'Revise the previous Maths ANA question papers' (Focus-group C, line 162).
>
> 'ons het ook ou toetse gekry. Vorige jaar se toets' (we received previous tests. Previous year's tests) (Focus-group A, line 28).
>
> '…eksemplare en alles wat hulle gestuur het geanaliseer' (analyzed the exemplars and everything that they sent us) (Teacher E, line 9).

Although some learners received papers of the previous years' ANA tests, there were also learners that did not receive papers of the previous years for revising the ANA.

> 'No papers for ANA for practice' (Focus-group A, line 157).

Teacher E also worked multiple choice questions into her own test and examination papers so that the learners were more comfortable with multiple choice questions.

> 'ook meervoudige keuse vrae ingewerk' (also included multiple choice questions) (Teacher E, line 12).

Teacher C and E experienced pressure regarding the ANA. According to them they had to speed through the work to complete the work schedule before the ANA was written in September 2014.

‘ANA is set to the pressure’ (Teacher C, line 31).

‘Therefore the ANA is, when it comes to the pressure, affecting everyone’ (Teacher C, line 152).

‘Jy jaag hom af’ (you speed through the work) (Teacher E, line 63).

‘Gedruk met die ANA’s om eintlik die werk af te handel’ (the ANA pressured us to complete the work) (Teacher E, line 41).

Time was an immense factor for Teacher E.

‘maar tydsgewys, is dit ‘n groot, groot, groot bron van kommer’ (time wise it is a very big source of concern) (Teacher E, line 47).

Teacher E experienced more pressure regarding the ANAs than from her Grade 12 learners.

‘ek is selfs meer gedruk met my 9’s as wat ek met my Matrieks is’ (I am more pressurized with the 9s than with the Matrics) (Teacher E, line 48).

From the interviews conducted it seems like most of the teachers focused on the syllabus for the Grade 9 learners and did the ANA on the side-line.

‘Ons het nie as sulks op die ANA’s gefokus nie’ (we did not focus on the ANAs) (Teacher D, line 4).

‘ANA is a waste of time to me’ (Teacher C, line 54).

‘ek doen dit heeltemal op die sideline’ (I do it on the side-line) (Teacher B, line 35).

‘As daar so 10 minute oor is van die tyd, dan werk ons op ANA’s’ (if there is about 10 minutes left, we work on the ANAs) (Teacher B, line 37).

‘Fokus nie so baie op die ANA nie’ (Did not focus that much on the ANA) (Teacher A, line 33).

‘As sy ‘n tydjie gehad het, het sy vir ons gesê ok, ons gaan gou-gou ‘n ANA vraag doen’ (if she had time left, she said that we are quickly going to do an ANA question) (Focus-group D, line 591).

‘…die ANA is maar net ‘n by-ding’ (the ANA is a side thing) (Focus-group D, line 600).

> ‘Sy het ons gesê omdat dit departementeel is hoef ons nie so erg daaraan te konsentreer nie, ons moet meer op ons skool s’n konsentreer’ (she said because it is from the department we have to concentrate more on our school paper and not on the ANA) (Focus-group B, line 131).

The majority of the teachers experienced pressure to do the work quicker and had to modify their work schedule to match the ANA preparation. They arranged with the learners to come for extra lessons during weekends or after school hours to prepare them for their own Grade 9 syllabus as well as for the ANA test.

> ‘…2 to 3 hours after school’ (Focus-group C, line 139).
>
> ‘He was making extra lessons for us’ (Focus-group C, line 156).
>
> ‘Ekstra middagklasse vir die Graad 9’s eenkeer ‘n week om juis die vierde kwartaal se werk bietjie te doen’ (extra afternoon classes for the Grade 9s once a week to do the fourth term’s work) (Teacher A, line 151).
>
> ‘We are forced to prepare them on Saturday’s’ (Teacher C, line 25).
>
> ‘It really affects a lot and based on that because we have to prepare twice. Preparing for the ANA, preparing for the pace’ (Teacher C, line 14).
>
> ‘Pushing in the afternoon on Saturdays you have to bring the learners for extra class for ANA’ (Teacher C, line 460).
>
> ‘Week voor die ANA’s of twee weke het ons ‘n Wiskunde-dag gehad. Toe het ons ou ANA vraestelle deurgewerk’ (a week or two before the ANA we had a Mathematics day. We worked through previous ANA papers) (Teacher D, line 13).
>
> ‘Wiskunde-dag…was vir my waarop ek nou bietjie gefokus het op of so ietsie wat ons dalk nog nie gedoen het nie’ (Mathematics day…where I could focus on work that we have not done yet) (Teacher D, line 162).
>
> ‘Wiskunde-dag het ek gaan kyk….hulle kan dit ook moontlik vra’ (Mathematics day I checked… they can probably ask this as well) (Teacher D, line 215).

Teacher A gave her learners tasks in the third term to cover the work of the fourth term.

> ‘van die vierde kwartaal se take wel in die derde kwartaal doen’ (we did tasks from the fourth term in the third term) (Teacher A, line 40).
>
> ‘Vierde kwartaal se werk te behandel, sodat die kinders bietjie… sodat ons net die sillabus kan klaarkry’ (tasks of the fourth term, so that we can finish with the syllabus on time) (Teacher A, line 42).

To handle the pressure of the ANA, Teacher C summarized some of the chapters from the Grade 9 syllabus for his learners.

> ‘…try to make a summary of that chapter....give them questions on to understand’ (Teacher C, line 186).
>
> ‘Comes to ANA, we categorize chapters for ANA according to the weeks’ (Teacher C, line 476).

Overview

The literature review of Shulman (cf. 2.3.5) and Ball (cf. 2.3.6) revealed that the planning of lessons plays a core part in the education process. Although it is the duty of the DBE to prescribe the subject matter to be taught in a specific subject it is the responsibility of the teacher to make a decision of what he/she intends to discuss in every lesson.

Fenstermacher and Soltis (cf. 2.4) viewed the planning of lessons as Method according to the MAKER framework. The listings of the participants highlighted that all of the teachers interviewed followed the syllabus as prescribed by the DBE.

In the interviews conducted, learners stated that their teachers gave them papers of the previous years’ ANA to prepare them for the ANA in 2014. According to Kolb (cf. 2.2.3) learning takes place through an experiential learning cycle. He pointed out four steps namely: concrete experience; reflective observation; abstract conceptualization and active experimentation. Preparing learners for the ANA (previous years’ test papers) can easily cause that learners are not exposed to the four steps in Kolb’s learning cycle. The use of test scores and examination results in teaching focuses teaching on test

content and trains learners on how to pass tests (cf. 3.8.2). From the response of Teacher C it appeared that 'teaching to the test' does occur.

Out of all the teachers interviewed only two of them stated that they experienced the pressure of the ANA to complete the syllabus on time. The researcher realized that the statements of the other teachers who said they didn't experience the pressure of the ANA were contradicting each other because all of them made extra time available for the learners to complete the Grade 9 syllabus. Therefore it can be assumed that there had to be pressure from the ANA to complete the work before learners wrote the ANA test in September 2014.

From the responses of the learners' and the teachers' interviews, it appeared that some of the teachers and learners, who took part in this research study, acknowledged the importance of the ANA. The analysis of the data obtained from the interviews with the teachers, supported the data obtained from the interviews with the learners.

5.5.1.2 Teaching style

As mentioned in Chapter 2, there are three teaching approaches (cf. 2.4) namely the Executive, Facilitator and Liberationist approach. To compare and contrast these three approaches to teaching, Fenstermacher and Soltis (2004) developed the MAKER framework (cf. 2.4). When conducting the interviews the researcher discovered that the main purpose (Ends) of all the teachers interviewed was to make sure that the learners pass Grade 9 and have the basic knowledge (Knowledge) and skills of Mathematics.

> '…wat jy moet vaslê… so dit waarop ons fokus veral die faktorisering, dit wat ons weet wat belangrik is' (what you have to capture… where you have to focus on especially factorization…that we know what is important) (Teacher D, line 50).
>
> 'So ons probeer rêrig fokus op dit wat 'n basis gaan lê vir Graad 10 en die toekoms' (we really try to focus on what is important for Grade 10 and for the future) (Teacher D, line 53).
>
> 'I want all learners to do Mathematics' (Teacher C, line 227).
>
> '… see all learners in Grade 9 going straight to Grade 10' (Teacher C, line 256).

‘Ons dril, ons verduidelik, ons gee ekstraklasse, ons merk huiswerk….jy dril’ (we drill, teach, give extra classes, mark the homework …drill) (Teacher B, line 86).

‘Dat hulle so veel as moontlik graad 10-Wiskunde neem’ (that most of them take Mathematics in Grade 10) (Teacher B, line 236).

‘Ek glo maar in drilwerk’ (I believe in drill work) (Teacher B, line 242).

‘Ek lê nogsteeds klem op dit wat belangrik is vir graad 10-Wiskunde en vir verdere Wiskunde’ (I still emphasize on what is important for Grade 10 Mathematics and for further Mathematics) (Teacher A, line 32).

‘Ek wil graag hulle leer om meer selfstandig te werk’ (I want to teach them to be more independent) (Teacher E, line 110).

‘Aan einde van Graad 9 moet leerders die graad 9-sillabus onder die knie hê om hulle voor te berei vir graad 10-Wiskunde, die basis en die grondslag moet gelê wees vir graad 10-Wiskunde so dis my einddoel dat hulle kennis hê’ (at the end of Grade 9, the learners must know the Grade 9 syllabus to prepare them for Grade 10 Mathematics, the basics and the foundation must be there for Grade 10 Mathematics) (Teacher A, line 182).

‘Om jou sterker kind te help om die oorgang na Graad 10 toe makliker te maak…jou gemiddelde kind half meer te wen vir Wiskunde’ (to guide your stronger learner to move to Grade 10 …and to win your average learner for Mathematics) (Teacher E, line 119).

‘We are forced to change the style, because of the thing on ANA’ (Teacher C, line 203).

Overview

In the MAKER framework (cf. 2.4) the teacher as Executive placed emphasis on Method and Knowledge (methods of teaching and knowledge of subject matter). When viewing the MAKER framework by Fenstermacher and Soltis (cf. 2.4) it can be assumed that the main purpose (Ends) of the teachers interviewed were to make sure that the learners pass Grade 9. The Knowledge and Method components of the MAKER framework were more prominent in the interviews with teachers where the driving force in the teaching-learning situation spells out exactly what the learners need to know. The teachers interviewed strongly focused on the Mathematical knowledge needed to progress to

Grade 10. Based on evidence from the literature (cf. 2.4) and the empirical research teachers interviewed followed an Executive approach.

5.5.1.3 Knowledge of the teacher

In order to conduct any kind of job properly, one should have the knowledge of how to do it. As mentioned in the literature study in Chapter 2, Young (cf. 2.3.4) and Ball (cf. 2.3.6) stated that teachers need knowledge of content to conform their teaching practice. In Figure 2.2 Ball (cf. 2.3.6) showed how teachers' Mathematical knowledge relates to both Subject Matter Knowledge and Pedagogical Content Knowledge. Darling-Hammond and Baratz-Snowden (2005) emphasized that "teachers must know the subject they will teach" (Darling-Hammond & Baratz-Snowden 2005:14). Shulman's (cf. 2.3.5) theory of Pedagogical Content Knowledge emphasized that the centrality of this knowledge lies in the notion that the teacher should have the capacity to bridge Content Knowledge to his/her practice of teaching and the nature of this bridge requires a clear knowledge and understanding of the conceptions of three key areas namely learners, curriculum and social context. Teachers must first know and understand the subjects they teach in order to help learners to develop a rich understanding and appreciation of the content. Shulman (1986) stated that "in the face of student diversity, the teacher must have a flexible and multi-faceted comprehension [of subject matter], adequate to import alternative explanations of the same concepts or principles" (Shulman 1986:9).

From a theoretical perspective the teachers' qualifications (see Table 5.1) showed that they should have the necessary subject-matter knowledge expected of a teacher to teach Mathematics at Grade 9 level. Two of the five teachers interviewed had two years' teaching experience, one of the teachers had ten years' teaching experience and three of the teachers had between 27 to 39 years' teaching experience. It can be said that the range of teaching experience of the teachers interviewed were wide.

Teachers interviewed were consistent with the view that teaching requires basic skills, Content Knowledge and general pedagogical skills and they all believed that their knowledge of the subject is up to standard. All teachers' responses were in line with Teacher A and B.

'…na 39 jaar moet ek wees' (after 39 years I have to) (Teacher B, line 229).

'…ek is tevrede oor my kennis' (I am satisfied with my knowledge) (Teacher A, line 108).

Some of the teachers reported that they were still learning each and every day.

'I am satisfied with my knowledge of the subject …I am learning each and every day' (Teacher C, line 431).

'…ekke leer nog maar' (I am still learning) (Teacher D, line 149).

Two of the five teachers interviewed were Heads of Department and revealed that they were available to novice (beginner) teachers if they wanted to know something about the syllabus. Teacher B who was Head of Department of her school informed the researcher that the novice teachers at her school's knowledge were risky.

'nuwetjies wat skrikwekkend min weet' (the knowledge of the new teachers is frightening) (Teacher B, line 191).

Teacher E referred to the beginner teachers as 'the lost generation' because there was a time that learners did not have Geometry in their Mathematics paper in school. From 2007, the DBE removed Geometry from the Mathematics Paper Two. From 2007, Geometry surfaced in Paper Three. From 2012 CAPS were implemented for the Grade 10 learners and Geometry formed part of Paper Two again. These learners that are now the 'beginner teachers' have a lack of knowledge specifically in the Geometry part of Mathematics.

'jong onderwysertjies wat eintlik die basiese kennis van Meetkunde nie voldoende het nie' (young teachers that lack the basic knowledge of Geometry) (Teacher E, line 213).

Although the teachers indicated that they had sufficient knowledge to teach Mathematics at this level, they were concerned about the knowledge base of novice teachers entering the teaching profession.

'basiese kennis is daar, maar ek dink hulle… leer saam met hulle skoolhou' (basic knowledge is there... they learn while teaching) (Teacher B, line 197).

All teachers reported that a Grade 9 teacher has to have school teaching experience from Grade 8 to 12.

> '…hulle moet die sillabus tot by Graad 12 ken' (they have to know the syllabus up to Grade 12) (Teacher B, line 207).
>
> '……dat jy weet waarnatoe jy werk…' (that you know what you are working towards) (Teacher B, line 210).
>
> 'every teacher must understand the basics so that it becomes easier for the teacher to present' (Teacher C, line 412).
>
> '…alle onderwysers moet gekwalifiseerd wees om tot matriek Wiskunde te kan gee om Graad 8 en 9 te gee' (all teachers must be qualified to teach Mathematics to matric to be able to teach Grade 8 and 9) (Teacher A, line 95).
>
> '…hulle moet al eintlik seniors gegee het om Graad 9 te gee' (they had to teach seniors before they teach Grade 9) (Teacher D, line 136).

Overview

In the literature review Shulman (cf. 2.3.5) and Ball (cf. 2.3.6) stated the importance of SCK and PCK which included the in-depth understanding of the structures of the subject matter. The teachers highlighted the importance of Knowledge (cf. 2.4) at the Mathematical Horizon as highlighted by Ball (see Figure 2.2) when they referred to the importance of Grade 9 Mathematics teachers teaching Mathematics up to Grade 12.

Knowledge as core element of the MAKER framework of Fenstermacher and Soltis (cf. 2.4) has to do with subject competence of the teacher. All teachers interviewed studied Mathematics at a post-matric level (see Table 5.1) and all teachers were qualified to teach Mathematics in GET at the time of the research study. Therefore it can be assumed that the teachers who were interviewed had the necessary SCK and PCK to teach Grade 9 Mathematics.

Even though the teachers indicated that they had sufficient knowledge of Mathematics at this level (Grade 9) they were also concerned about the knowledge base of novice teachers entering the teaching profession.

5.5.2 Theme 2: Learning

Both Piaget (cf. 2.2.1) and Vygotsky (cf. 2.2.2) provided important views in their theories on the cognitive development of the learner. According to Piaget the cognitive growth of the learner is a process of assimilation and accommodation. Vygotsky stated that language development and the ZPD are essential. It is therefore important that the current knowledge of learners and the level of understanding of this knowledge should be the starting point of teaching as described in Chapter 2 of the literature review (cf. 2.2.3; 2.3.3; 2.3.5). This implies that teachers should determine what learners know and understand and then align their teaching accordingly. In a Mathematics classroom the teacher needs to design lessons that empower learners to perform a task under the guidance of the teacher. Effective or meaningful learning is conceived as occurring when a learner constructs his or her own knowledge that can be used as a tool to interpret the world and to solve complex problems. This implies that learners must be self-regulated in their learning, and that they need to be motivated to continually use and broaden their knowledge base. Learners need to develop strategic learning behaviours, which mean that they must master effective strategies for their own learning (Segers, Dochy & Cascallar 2003:1) (cf. 2.2.4; 2.3.3; 2.3.5).

5.5.2.1 Influence of the ANA on understanding and learning of Mathematics

In the literature review in Chapter 2, Piaget (cf. 2.2.1) stated that the growth of knowledge is the result of formation made by the learner's understanding of the subject. From the interviews conducted with the learners in the focus-groups, some of the learners believed that Mathematics is not a learning subject.

> 'Wiskunde is vir my oor die algemeen net verstaan' (for me Mathematics is in general only to understand) (Focus-group D, line 50).
>
> 'ek nog nooit Wiskunde as 'n leervak gesien het nie' (I have never seen Mathematics as a learning subject) (Focus-group D, line 64).
>
> 'dis maar meestal verstaanwerk' (mostly it is understanding work) (Focus-group B, line 50).

What the Grade 9 ANA test has succeeded in doing, was to provide a better basis for deciding what subjects learners should take in Grade 10 to 12, for instance whether learners are equipped to take Mathematics, or whether they should take Mathematical Literacy (DBE 2014a:24).

> ‘Choice between Maths and Maths Lit’ (Focus-group A, line 214).
>
> ‘Met die ANA vraestelle ook dan besef miskien moet hulle Wiskunde of Wiskunde Geletterdheid vat’ (with the ANA test they realize that they should take Mathematics or Mathematical Literacy) (Focus-group D, line 18).
>
> ‘Mense hulle oë oop gemaak om te sien, jis hierdie Wiskunde…ek gaan eerder Wiskunde Geletterdheid aan vat’ (open the eyes of people, to see…this Mathematics...I rather take Mathematical Literacy) (Focus-group D, line 230).
>
> ‘wake-up call om te sien of hulle Wiskunde Geletterdheid of gewone Wiskunde moet vat’ (wake up call to see that they have to take Mathematical Literacy or pure Mathematics) (Focus-group D, line 263).
>
> ‘die ANA ons miskien laat besef jy moet jou keuse reg maak. Jy gaan of Wiskunde kies of Wiskunde Geletterdheid kies’ (the ANA made your realize that you have to make a choice. You are going to choose between Mathematics or Mathematical Literacy) (Focus-group E, line 350).

Although the learners experienced the ANA test as difficult and that the questions were asked from a different angle (cf. 5.5.3.2) they believed that the ANA test was valuable because the type of questions prepared them to work harder in Mathematics and also to show that Mathematics questions can be asked in more than one way.

> ‘Het al my foute uitgewys’ (showed me all my mistakes) (Focus-group A, line 12).
>
> ‘…show you what I was struggling in and what I was stronger in…’ (Focus-group A, line 14).
>
> ‘…stel ons meer bloot aan meer verskillende maniere van vra…’ (expose us to different ways of questions) (Focus-group B, line 21).

'…kan jy sien waarin jy swak gedoen het en dit verbeter' (see where your weak points are and improve it) (Focus-group B, line 421).

'There are so many ways that you can solve a Maths problem' (Focus-group C, line 87).

'…pressurized me to study very hard' (Focus-group C, line 110).

'Ons word blootgestel aan ander tipe vrae' (we are exposed to different type of questions) (Focus-group E, line 16).

'…daar is meer as een manier om hierdie som te doen' (there is more than one way to solve this sum) (Focus-group D, line 4).

'Ons word blootgestel aan ander manier van dink ook' (we are exposed to different ways of thinking) (Focus-group E, line 18).

'…ek moet dieper in die vraag in kyk' (I had to look deeper in the question) (Focus-group D, line 37).

'… dit in trurat ook kan leer…' (to learn it in reverse) (Focus-group D, line 43).

'…nie alles word nie reguit gevra nie' (not everything is asked straight forward) (Focus-group D, line 109).

'…insigvrae het ons gehelp want nie al die vrae gaan altyd straight forward wees nie' (the insight questions helped us because not all the questions are always straight forward) (Focus-group D, line 129).

'…berei jou voor vir wat voorlê' (prepare you for what lies ahead) (Focus-group D, line 241).

'…aanduiding van hoe die department hulle toetse sal vra' (show how the department is going to ask the tests) (Focus-group D, line 485).

'Om wyer te dink' (to think wider) (Focus-group E, line 38).

Overview

The learners interviewed, experienced the ANA test as difficult, because they believed that most of the questions in the ANA test were asked in a different way. Learners highlighted that they were not used to the way the questions were asked in the ANA

test. Although the paper had ‘tricky’ questions, they also experienced that the paper prepared them to take Mathematics serious and that questions may be asked in a different way. According to the learners the ANA test also helped them to make a decision whether to take Mathematics or Mathematical Literacy.

5.5.2.2 Feedback from the ANA

One of the purposes of assessment is to provide feedback to the learners as part of the learning process. Shute defined feedback as “information communicated to the learner that is intended to modify his or her thinking or behaviour for the purpose of improving learning” (Shute 2008:154). In the literature review (cf. 3.6) Hattie and Timperley believed that feedback can have a positive effect on learners depending on the nature of delivery.

From the interviews conducted with the teachers, Teacher D indicated that she only gave the ANA test’s marks, question paper and memo to the learners.

> ‘maar ons het dit nooit vir hulle teruggegee nie…hulle het nie fisies hulle vraestelle..’ (we did not give it back to them…they did not physically had their papers) (Teacher D, line 271).
>
> ‘…ons het net hulle punte vir hulle gegee...’ (we only gave them their marks) (Teacher D, line 271).
>
> ‘ons het vir hulle die memo en die vraestel afgerol’ (we gave them a memo and a paper) (Teacher D, line 284).

All teachers interviewed explained that they gave the learners an ANA test and memo of 2014.

> ‘ons sal na die tyd vir hulle ‘n memo weer uitdeel…’ (afterwards we will hand out a memo to them) (Teacher A, line 162).
>
> ‘…ons het min tyd…ek gee die memorandum vir hulle…’ (we have little time…but I give them the memorandum) (Teacher B, line 294).
>
> ‘Usually give the memo’ (Teacher C, line 557).

> ‘ons het vir hulle die memo en die vraestel afgerol’ (we gave them a memo and a paper) (Teacher D, line 284).

Boud (2000:158) claimed that “unless students are able to use the feedback to produce improved work, though, for example, redoing the same assignment, neither they, nor those giving the feedback, will know that it has been effective”. Thus it can be said that effective feedback leads to successful learning. Teachers A, B, C and E indicated that they gave the learners their written papers back and revised the paper with the learners.

> ‘maar as ons dit teruggekry het, sal ons dit teruggee aan kinders voor die November eksamen en vir hulle sê kom ons kyk waar was julle foute’ (if we received it back, we will give the paper back before the November exam and inform them were their mistakes were) (Teacher A, line 164).

> ‘ons het baie min tyd, maar ons, ek gee die memorandum vir hulle en ons gaan probleem sommetjies oor’ (we have little time, but I give them a memorandum and discuss a few problem sums) (Teacher B, line 295).

> ‘give the feedback and to discuss it with them’ (Teacher C, line 558).

> ‘You give them back.....as part of revision’ (Teacher C, line 545).

> ‘bespreek soos ‘n volwaardige vraestel wat hulle geskryf het. Met ander woorde hulle moet weer die verbeteringe gaan doen’ (discuss as a paper that they wrote. In other words they had to do the corrections) (Teacher E, line 319).

According to the learners interviewed, some of them only received their marks of the ANA test written in September 2014.

> ‘they gave our percentages’ (Focus-group A, line 59).

> ‘het ook nie ons toetse teruggekry nie…net die punte gekry’ (did not received our tests…only the marks) (Focus-group A, line 76).

Some of the learners did not receive their marks.

> ‘Nee, ons het ook nie ons punte teruggekry nie’ (no, we did not receive our marks back) (Focus-group B, line 231).

‘hulle het net gesê ons het swakker in die ANA toets gedoen maar ons het nooit die punte gesien en niks met ons gekontroleer’ (they told us that we did terrible in the ANA test but we did not receive our marks or got feedback) (Focus-group B, line 295).

Some learners did not see their written papers of the ANA tests written in 2014.

‘Want ons het gevra daarvoor, maar het dit nie gekry nie’ (we asked for it, but did not receive it) (Focus-group B, line 256).

‘she didn’t give us the papers’ (Focus-group A, line 63).

‘Nie ons toetse terug gekry nie’ (did not receive our tests) (Focus-group A, line 76).

Some of the learners received an ANA 2014 memo, but the teacher did not explain anything.

‘Ons het memo’s gekry…dis al’ (we received memo’s...only that) (Focus-group B, line 251).

‘Maar nooit iets vir ons verduidelik nie’ (never explained anything to us) (Focus-group A, line 106).

Some of them did not receive a memo.

‘nie memo’s gekry’ (did not receive memo’s) (Focus-group D, line 411).

‘hulle het nooit vir ons ‘n memo en so gegee nie’ (they did not give us a memo) (Focus-group A, line 94).

Some of the learners did not receive a memo but the teacher explained the questions of the ANA 2014 test.

‘ons het geen memo gekry nie. Die onderwyser het met ons deurgegaan in die klas’ (we did not receive a memo. The teacher explained it in the class) (Focus-group A, line 114).

Some of the learners interviewed received the written ANA scripts and the teachers revised the ANA 2014 test with them.

‘sy het ook die vraestelle deurgegaan’ (she went over the paper) (Focus-group E, line 281).

> ‘our teacher would revise the memos with us explaining to us some of the questions that we didn’t knew’ (Focus-group C, line 203).
>
> ‘we worked as a group showing our weak points’ (Focus-group C, line 248).

Some of the learners received their written ANA 2014 scripts but the teacher did not explain the questions.

> ‘het nie self die toets deurgegaan met die onderwyser nie’ (did not go over the test with the teacher) (Focus-group D, line 438).
>
> ‘toets vir ons gegee maar niks vir ons gesê nie’ (gave us the test but didn’t say anything) (Focus-group A, line 70).

As part of the feedback on the results of the ANA test, the DBE compiled a Diagnostic Report. The Diagnostic Report provided a detailed analysis of the knowledge and skills displayed or failed to display in the ANA test administered in each grade and subject. The target audience for the report was learners, teachers, principals, management of curriculum implementation, curriculum and management at district/circuit level and School Management Teams (SMTs) in schools (DBE 2014a:4). Teacher A said that she knew nothing about a Diagnostic Report.

> ‘weet nie of ons Departementshoof dit wel ontvang nie…ons as onderwysers kry dit nie’ (don’t know if the Head of the Department received it…but we as teachers did not received it) (Teacher A, line 196).

Teacher B reported that she might have received the Diagnostic Report, but she ignored it because she saw it was from the Department and she just filed it in her cupboard.

> ‘kon dit dalk gekry het… maar dan lê dit in my kas’ (could have received it, but then it is in my cupboard) (Teacher B, line 321).

Teacher B said that she did her own Diagnostic Report but she could not present it when asked for.

Only Teacher C and E received the Diagnostic Report from the department. Teacher E did not physically analyze the Diagnostic Report but she did an error analysis on her learners' papers to see where the learners' strong and weak points were.

> 'We just receive them and check the mistakes that we did based on the Diagnostic Report' (Teacher C, line 567).

> 'Ons doen meer 'n error analysis' (we do an error analysis) (Teacher E, line 450).

Teacher D said that she also knew nothing about a Diagnostic Report, but she compiled her own Diagnostic Report.

> 'maar ek het dit gedoen…het dit fisies so gaan opsom' (I did it…physically a summary) (Teacher D, line 313).

Overview

How to communicate the findings of assessment to all parties involved is part of the Method core element of the MAKER framework of Fenstermacher and Soltis (cf. 2.4). In the literature review in Chapter 3 (cf. 3.6) Gipps and Tunstall distinguished between two types of feedback namely: evaluative and descriptive feedback. Evaluative feedback (cf. 3.6.1.1) gives the learner a summary of how he/she has done and how to improve the learning process. Descriptive feedback (cf. 3.6.1.2) gives information in the form of written comments or conversations that help the learner to understand what he/she need to do in order to improve. From the literature study (cf. 3.6) it can be assumed that for feedback to be effective, the learner has to engage with the questions which they had wrong or partly wrong. From the interviews conducted with the teachers, Teacher A, B, C and E mentioned that they revised the ANA test with the learners by discussing their mistakes. It must be noted that the teachers that were interviewed did not teach all the Grade 9s in their school. Based on the interviews with the teachers it can be concluded that there were evidence of evaluative and/or descriptive feedback. The majority of learners interviewed stated that they did not revise the ANA test neither did the teacher show the areas of weakness. Thus it can be concluded that the majority of learners did not receive evaluative and/or descriptive feedback for the purpose of strengthening teaching and learning.

5.5.2.3 Mathematical knowledge of the learner

From the literature review, prior knowledge, conceptions of learning and strategies can affect the process and outcomes of learning (cf. 2.2.4; 2.3.3; 2.3.5). According to Bernstein (cf. 2.3.3), De Corte (cf. 2.2.4) and Shulman (cf. 2.3.5) teaching should always start from a learner's current conceptions and prior knowledge.

Teacher A experienced her learners as having enough knowledge to handle Grade 9 Mathematics.

> 'dink hulle het genoeg kennis om Graad 9 te kan handle' (they have enough knowledge to handle Grade 9) (Teacher A, line 86).

The majority of teachers highlighted that their Grade 9 learners did not have appropriate knowledge.

> 'So daar is regtig kinders wat ok nog 'n geweldige agterstand het, hulle ek dink hulle het 'n mindshift gemaak hulle kan nie Wiskunde doen nie' (there are learners with a tremendous backlog, they, I think they have made a mind shift that that they cannot do Mathematics) (Teacher B, line 157).

> 'en baie het rêrig net nie die vermoë nie' (most of them do not have the ability) (Teacher D, line 130).

> 'jou gemiddelde na swak leerder beslis nie. Jou gemiddelde na sterk leerder soos die groepie wat jy ook net nou ook ondervra het, wat tans Wiskunde neem, ja' (your average to weak learner certainly not. Your average to bright learner, like the group that you asked which take Mathematics, yes) (Teacher E, line 181).

Teacher A, B and D experienced that there was a gap between Primary and Secondary school and that was the reason why children didn't perform well in Grade 9.

> ''n sprong vanaf Laerskool na Graad 8 toe. Wat Graad 8 bietjie moeilik maak vir hulle' (jump from the Primary school to Grade 8. Which makes Grade 8 little harder for them) (Teacher A, line 87).

> '....van die Laerskool af…daar kom ons gap' (from the Primary school...there is the gap) (Teacher D, line 117).

'....kinders vaar swakker in Graad 8 as hulle hier aankom…ek dink eerlik die Laerskool het te veel speel, te min dril' (children in Grade 8 when they arrive here…honestly I think the Primary school have too much play and no drill) (Teacher B, line 126).

Overview

In the literature review in Chapter 2 (cf. 2.2.4) De Corte suggested that learners should reflect on their own learning and determine what they know and identify areas in which they need more information. Teachers can only help their learners during the teaching process when they know what the learners know. People generally attempt to make sense of new information by linking it to their prior knowledge. Thus, what learners already know substantially influence their subsequent learning processes.

The majority of teachers highlighted that their Grade 9 learners did not have appropriate knowledge. They stated that the knowledge bases in Mathematics of learners coming from the Primary school were not sufficient. Thus it can be concluded some Grade 9 learners lacked prior knowledge.

5.5.3 Theme 3: Assessment

As mentioned in the literature study in Chapter 3 (cf. 3.3; 3.4; 3.5), research has shown that teachers' use of assessment can lead to significant progress in learners' achievement, when used as a process of continuous improvement to inform instruction and improve student learning (William 2010:107-122).

Assessment has various functions, such as revealing the level of competences for the learners themselves, and motivating and directing learning. As Chalmers and Fuller stated "it guides their (learners) decisions about what is important to learn, affects their motivation and perceptions of self-competence and influences their approach to learning" (Chalmers & Fuller 1996:45). Therefore assessment is a bridge between the learning and teaching process.

The following sub-themes emerged from the interviews with the teachers and focus-groups namely: the influence of the ANA on assessment and whether the ANA tests the full range of Mathematical knowledge required in Grade 9.

5.5.3.1 Influence of the ANA on assessment

As indicated in Chapter 3 (cf. 3.3; 3.4; 3.5), assessment plays an important role in education and the learning process of learners. Thus can it be assumed that the assessment process is clearly embedded within the curriculum and learning process. It serves not only to report on learning but to actually enhance and improve learning.

In all the interviews conducted, the researcher was informed that assessment in the teachers' classrooms took place as usual. Teachers indicated that they used assessment procedures for example informal tests, formal tests, examinations, assignments to evaluate the progress of their learners.

> 'Informal tests, formal tests, exams' (Teacher C, line 302).
>
> 'ons het nogsteeds toetse geskryf, net soos altyd deur die kwartale, ons het nogsteeds ons Junie eksamen' (not much…. we wrote tests, as usual through the term, we have our June examination) (Teacher A, line 38).

ANA did not change the assessment process in the teachers' classes.

> 'Dit my anderster laat dink oor assessering nie' (I don't think differently about assessment) (Teacher D, line 73).
>
> 'Ek het niks verander nie' (I didn't change anything) (Teacher B, line 103).
>
> 'Maar die verdere assessering het dieselfde gebly daar was niks rêrig verskillend nie' (the assessment remained the same there was nothing different) (Teacher A, line 43).

Grade 9 is the end of the GET phase. From Grade 10 learners can choose between Mathematics and Mathematical Literacy. Teacher B and E highlighted that tests/examinations papers are set in line so that the average learner can pass Grade 9.

> 'So ons vra straight forward… wat dit miskien bietjie makliker maak' (we ask straight forward, which make it a little bit easier) (Teacher B, line 409).
>
> 'ek wil nie sê skool standaard afbring nie, maar meer jou gemiddelde kind ook akkommodeer om hulle deur te kry met die verhoogde 40%' (I would not say to lower the standard of the school, but to accommodate the more average learner, to pass them on the increased 40%) (Teacher E, line 46).

During the interviews with Teacher C and D, the researcher experienced that the learners did not take the ANA serious because it did not count towards their final grade.

‘Make it part of the formal task, it will be more worth’ (Teacher C, line 62).

‘It is very frustrating because it is an informal task’ (Teacher C, line 68).

‘If they know it is not count for their marks, they don’t take it seriously’ (Teacher C, line 72).

‘But immediately when they know this one is formal and is part of their CASS, they will start to take their work serious’ (Teacher C, line 76).

‘Verseker as hy getel as ‘n opdrag of as ‘n deel’ (for sure if it counted as a task or part of it) (Teacher D, line 30).

‘Just wrote the ANA without any formal preparation’ (Teacher C, line 87).

‘Hulle sou voorberei het, defnitief want hulle weet dan tel dit vir die…’ (They would definitely have prepared if they knew it counted …) (Teacher D, line 32).

‘It was a formal task, the results of the ANA it will be something different’ (Teacher C, line 108).

‘As iets nou deesdae nie meer tel nie, dan gee hulle nie meer om nie’ (now a days if something doesn’t count, they do not care) (Teacher D, line 33).

‘It is going to be more powerful for learners’ (Teacher C, line 115).

‘If ANA was formal and the results of ANA and be something better’ (Teacher C, line 127).

‘… dink as dit getel het sou hulle dit meer ernstig opgeneem het’ (… think if it counted they would have taken it more serious) (Teacher D, line 221).

‘ANA becomes formal task’ (Teacher C, line 589).

‘…sou sê hulle moet dit net laat tel as ‘n CASS punt’ (…would say that they should let it count as a CASS mark) (Teacher D, line 330).

‘If can be formal if it is formal, they are going to prepare the learners they are going to prepare for the ANA’ (Teacher C, line 590).

Similar to the remarks of Teacher C and D, the learners in focus-group A, B, D and E also commented that they did not learn for the ANA test because it did not contribute towards their grading.

> ‘Maar ons het nie rêrig geworry nie, want dit het nie punte getel nie…’ (we did not worry because it did not count) (Focus-group A, line 176).
>
> ‘…ons leer nie eintlik vir die ANA nie….’ (we don’t actually learn for the ANA) (Focus-group A, line 233).
>
> ‘Hoekom moet ek vir ‘n ding leer as hy nie punte tel nie’ (why do I have to learn for something if it doesn’t count for marks) (Focus-group E, line 239).
>
> ‘…ons is maar negatief daaroor want ons kry dit nie op ons rapportpunt nie, so hoekom moet ons leer’ (we are negative about it because we do not get it on the report as a mark, why should we learn) (Focus-group A, line 235).
>
> ‘…dink dit is onnodig omdat dit nie punte tel op ons rapport nie, en die kinders gaan nie hulle beste gee as dit nie punte tel nie…nie hulleself voorberei nie’ (it is unnecessary because it did not count on the report and the children are not going to give their best because if it does not count…not preparing themselves) (Focus-group A, line 246).
>
> ‘The ANA does not promote…so why should we do it’? (Focus-group A, line 264).
>
> ‘…maar dit tel nie direk al daai punte nie…’ (it does not count directly all that marks) (Focus-group B, line 157).
>
> ‘...ek het nie geleer vir ANA nie want dis departementeel en dit tel nie’ (I did not learn for ANA because it is from the department and does not count) (Focus-group B, line 355).
>
> ‘…persoonlik was dit vir my maar net ‘n tydmors… dit het ook nie getel nie’ (personally it was a waste of time…it did not count either) (Focus-group B, line 368).
>
> ‘Wat help dit jy skryf ‘n toets, maar dit tel nie’ (what is the use to write a test, but it does not count) (Focus-group B, line 415).
>
> ‘…hoekom jy voel wil nie eintlik leer nie is omdat dit tel nie…’ (you feel that you don’t want to learn because it does not count) (Focus-group B, line 443).

'…ek het byvoorbeeld nie geleer … maar ek dink as ek geweet het dit tel, dan sou ek verseker harder geleer het' (for example I did not learn…if I knew it counted then I would have studied harder) (Focus-group D, line 273).

'…as ek geweet het dit sou die rapport getel en so, sou ek meer ingesit het en sou harder geleer het…' (if I knew it would have counted on my report, I would have put in more and studied harder) (Focus-group D, line 278).

'…die ANA nie getel het nie, het die kinders nie geleer nie…' (the ANA didn't count, the children did not learn) (Focus-group D, line 289).

'…nie geleer omdat hulle geweet het dit gaan nie tel nie…' (did not learn because they knew it did not count) (Focus-group D, line 296).

'…dit is 'n groot ding, dit moet tel' (it is a big thing, it has to count) (Focus-group D, line 306).

Overview

How learners are assessed is part of the Method core element of the MAKER framework mentioned by Fenstermacher and Soltis (cf. 2.4). In the interviews conducted with the teachers, the researcher realized that assessment in the Grade 9 Mathematics classes of the participants took place as usual. The learners wrote class tests, formal tests, tutorials, assignments and examinations. The data obtained from the teachers' responses in the interviews supported the learners' responses in the focus-group interviews that assessment took place as usual. Although assessment took place as usual, Teacher B and E highlighted that tests/examinations in their schools were set with the intention to pass the average learner.

From the interviews of the learners, the researcher noticed that the learners did not see the ANA tests as important due to the fact that the ANA tests did not contribute towards their formal test mark on their reports. It was also confirmed by teachers that the learners did not take the ANA serious.

5.5.3.2 ANA and the full range of Mathematical knowledge required in Grade 9

In the literature review Durkheim (cf. 2.3.1) viewed knowledge as the basis for a theory of curriculum development. Teachers interviewed (except Teacher E) revealed that the ANA 2014 test was up to standard. It tested the full range of Mathematics knowledge required of a Grade 9 learner.

> '…hulle toets regtig alles van graad 9-Wiskunde, die basiese goed' (they test everything from Grade 9 Mathematics, the basic things) (Teacher A, line 55).

> '…basiese vereenvoudiging kan doen, eksponente, hulle ja, toets die basiese kennis van 'n Graad 9, van die graad 9-sillabus, hulle toets die hele sillabus' (can do basic simplification, exponents, they yes, test the basic knowledge of a Grade 9, of the Grade 9 syllabus, test the whole syllabus) (Teacher A, line 57).

> '…want ek dink die standaarde het opgetel. Ek dink die standaard wat hulle uiteindelik in 2014 bereik het, is die regte standaard' (I think the standards picked up. I think the standard that they obtained in 2014 is the right standard) (Teacher A, line 76).

> 'Dis die regte Wiskunde wat getoets word, nie Wiskunde vaardighede nie, wat miskien in 2011 meer Wiskundige vaardighede getoets is…' (the right Mathematics are tested, not Mathematics skills, which they did in 2011) (Teacher A, line 77).

> 'Dit was vir my 'n goeie standaard vraestel gewees' (for me it was a good standard paper) (Teacher D, line 97).

> 'Ja, die standaard het tog bietjie verbeter na 2014' (yes the standard did improve in 2014) (Teacher B, line 11).

> '…hierdie is leerplan gebonde…' (this is according to the syllabus) (Teacher B, line 25).

> '…veral verlede jaar se vraestel was baie Wiskunde-gerig gewees' (especially last year's paper was aimed at Mathematics) (Teacher B, line 99).

> '…die omvang is baie goed…ek dink dit dek omtrent alles' (the range is good…I think it covers almost everything) (Teacher B, line 147).

> 'ANA it is standard' (Teacher C, line 319).

> '…up to standard for the learner doing Grade 9' (Teacher C, line 320).

'…test the knowledge of the children...' (Teacher C, line 328).

Even though the majority of teachers interviewed experienced the ANA 2014 test up to standard, Teacher E was of the opinion that the standard of the ANA 2014 test was too high.

'dit toets die kennis hier en daar op 'n te hoë vlak' (it tested the knowledge here and there on a high level) (Teacher E, line 164).

She experienced the ANA tests' level as high and the average learner could not master it.

'jou gemiddelde kind kan dit nie doen nie' (your average learner could not do it) (Teacher E, line 359).

She was of opinion that some of the questions were not on Grade 9 level but on the level of Grade 10.

'dis vir my meer graad 10-vlak' (for me it is on Grade 10 level) (Teacher E, line 357).

As stated earlier (cf. 5.5.1.1), the Assessment Guidelines of the ANA are arranged in columns with the following headings: content area, topics, concepts and skills and descriptive statements of what will be assessed in the ANA test (DBE 2015a:1-8). Teacher E was further of the opinion that the volume of the ANA content was too large for Grade 9 learners to handle.

'want as jou volume soos nou vir die September toets kleiner is, jou kind is meer voorbereid om die kleiner volume te hanteer' (if the volume is smaller, like the September test, then the child is more prepared to handle the smaller volume) (Teacher E, line 39).

Teacher E also experienced uncertainty because the schedule for the preparation according to the ANA test was not defined.

'hoe wyd gaan dit gevra word'? (How broad it going to be asked) (Teacher E, line 6).

All the learners that were interviewed wrote the ANA test in September 2014 as well as a test or examination paper of their school. Findings from the focus-groups revealed that the learners experienced the ANA 2014 test as difficult.

> ‘moeiliker as wat ons gedink het’ (more difficult than we thought) (Focus-group A, line 27).
>
> ‘die manier wat ons dit in daai toetse gekry het was verskillend gewees…’ (the way in that test was different) (Focus-group D, line 23).
>
> ‘....op ‘n vlak moeiliker is as wat ek oorspronklik altyd geskryf het’ (on a more difficult level than I’m used to) (Focus-group D, line 56).
>
> ‘....half met ‘n ompad gevra…’ (asked indirectly) (Focus-group D, line 107).
>
> ‘....dit was ‘n bietjie tricky gewees’ (it was tricky) (Focus-group D, line 113).
>
> ‘Die ANA-vraestel se bewoording was heeltemal anderster as die wat ons elke kwartaal doen’ (the ANA test’s wording was different from what we did during the term) (Focus-group E, line 45).
>
> ‘…ANA’s was makliker maar daar was vrae wat moeiliker was…’ (ANAs were easier but there were questions that were more difficult) (Focus-group D, line 138).
>
> ‘…daar was meer insigvrae in die ANA…’ (there were more insight questions in the ANA) (Focus-group D, line 175).
>
> ‘…ANA se manier hoe hulle dit vra, is baie anderster as wat onderwysers… dit sal vra...’ (the way they asked questions in the ANA is different from the way our teacher asked it) (Focus-group D, line 391).
>
> ‘…baie meer insigvrae, maar dit was moeiliker gewees oordat ons nie daai tipe vrae in die klas behandel het in Graad 9 nie...’ (was more insight questions….it was difficult because we did not do those questions in the class in Grade 9) (Focus-group D, line 505).
>
> ‘…daai was baie diep vrae gewees…’ (those questions were intense) (Focus-group D, line 507).
>
> ‘…was a little bit difficult …some of them was very tricky…’ (Focus-group C, line 13).

'…they ask questions differently than we know' (Focus-group C, line 61).

'…the department's question paper is tricky…' (Focus-group C, line 63).

'When the ANA paper came there the question papers on the scope was not in there' (Focus-group C, line 100).

'…it was different angle, but I need more mind to do it' (Focus-group C, line 107).

'…hoër standaard as wat ons hier by die skool…' (higher standard than in our school) (Focus-group B, line 10).

'…hulle vra die vrae anderster…' (they ask the questions differently) (Focus-group B, line 16).

'…omdat dit anders gevra het, is kon ons dit nie so maklik toepas…' (asked it differently, we could not apply it easily) (Focus-group B, line 224).

'The ANA test for me was more difficult than I expected' (Focus-group A, line 221).

Overview

Ends are merged with Knowledge by emphasizing that the proper end of education is for the learner to acquire Knowledge (cf. 2.4). The comments of all teachers (except Teacher E) highlighted that the ANA test of 2014 was up to standard. The paper tested the full range of Mathematics knowledge of what is expected of a Grade 9 learner as stipulated in the CAPS document of the General Education and Training (GET). Teacher E believed that the average learner could not do the ANA test due to the fact that some of the questions were at Grade 10 level. This was supported by the fact that the responses of the learners' interviews indicated that the ANA test paper was too difficult for them.

5.6 DOCUMENT ANALYSIS

The following documents were analyzed:

- The Diagnostic Report of Teacher D and the Diagnostic Report of the DBE of the ANA test written in September 2014.

- Questions of the ANA 2014 test and the questions of the test/examination written in September 2014 of the five sample schools.
- The results of the ANA 2014 test and the results of the September 2014 test/examination of the five sample schools.

The information obtained from the data analysis was used to verify and/or substantiate the information collected during the interviews of the teachers and focus-groups and to strengthen the evidence about the pedagogical perspective on the ANA in a Grade 9 Mathematics classroom.

5.6.1 Analysis of the Diagnostic Reports

Teacher D compiled her own Diagnostic Report on the ANA 2014 test, therefore the researcher did a document analysis on both the Diagnostic Report of the DBE and that of Teacher D. It is not the purpose of qualitative research to generalize findings and it is for this reason that the researcher decided to analyze these two documents even though it was envisaged that all schools would have a Diagnostic Report on the performance of their learners in the ANA test.

According to the DBE (DBE 2014a:53) the following content areas, knowledge and skills were assessed in the Grade 9 ANA 2014 test country-wide (nationally):

- Numbers, Operations and Relationships: this area included knowledge of integers and the ability to solve problems involving square roots, exponents, decimal fractions, scientific notation, percentages, ratio, direct and indirect proportion, simple and compound interest.
- Patterns, Functions and Algebra: this area included knowledge skills in that learners had to demonstrate the ability to find number patterns and solve algebraic expressions and equations.
- Space and Shape: in this area the learners had to show knowledge and skills in solving problems involving geometry of straight lines and geometry of 2-D shapes.
- Measurement: in this area the learners had to reveal knowledge and skills in applying the theorem of Pythagoras and finding the perimeter of 2-D shapes.

The specific areas of strengths and weaknesses of Grade 9 learners who wrote the ANA test in Mathematics in September 2014 nationally were summarized by the DBE (DBE 2014a:52). The areas of strengths and weaknesses are displayed in Table 5.3.

Table 5.3: Summary of learners' strengths and weaknesses in Grade 9 Mathematics in the ANA test written in September 2014

Areas of weakness	Areas of strengths
The following areas were identified as areas of weaknesses: • circumference and area of a circle; • perimeter and area of a trapezium; • congruency and similarity deductions; • angles opposite equal sides of a triangle; • Lowest Common Multiple; • square root and cube root; • direct and indirect proportion; • terminology and definitions in geometry; • factorization; • multiplication of fractions; • determination of the gradient and the equation of a straight line; • squaring of binomials; • products of binomials; • quadratic equations; • equations involving fractions; • determination of the general term; • determining the coordinates of a point; • addition and subtraction of fractions; • percentages; • angle relationships in parallel lines; • exponents; and • theorem of Pythagoras.	The following areas were identified as areas of strengths: • writing scientific notation; • finding the ratio of a given quantity; and • completing a number sequence.

DBE (2014a:52)

The researcher analyzed the Diagnostic Report of Teacher D and identified the strengths and weaknesses of the Grade 9 learners in School D that wrote the ANA Mathematics test in September 2014. An area in Mathematics was identified as weak if the average of learners in the particular question was less than 50% and it was identified as a strength if the average of the learners scored above 50% in the specific question. The areas of strengths and weaknesses are displayed in Table 5.4.

Table 5.4: Summary of learners' strengths and weaknesses in Grade 9 Mathematics of School D

Areas of weakness	Areas of strength
Learner responses showed weaknesses in the following areas: • circumference and area of a circle; • perimeter and area of a trapezium; • congruency and similarity deductions; • angles opposite equal sides of a triangle; • square root and cube root; • multiplication of fractions; • squaring of binomials; • products of binomial; • quadratic equations; • equations involving fractions; • completing a number sequence; • addition and subtraction of fractions; • angle relationships in parallel lines; and • theorem of Pythagoras.	Questions on the following areas were reasonably well answered: • writing scientific notation; • exponents; • factorization; • determination of the gradient and the equation of a straight line; • determining the coordinates of a point; • percentages; • direct and indirect proportion; and • simple and compound interest.

When comparing Table 5.3 and 5.4, the researcher observed that the following areas of weaknesses in the Diagnostic Report of the DBE and Teacher D were similar:

- circumference and area of circle;
- perimeter and area of a trapezium;
- congruency and similarity deductions;
- angles opposite equal sides of a triangle;
- square root and cube root;
- multiplication of fractions;
- squaring of binomials;
- products of binomials;
- quadratic equations;
- equations involving fractions;
- addition and subtraction of fractions;
- angle relationships in parallel lines; and
- theorem of Pythagoras.

There were more areas of strengths in the Diagnostic Report of Teacher D than areas of strengths in the Diagnostic Report of the DBE. From Table 5.3 and 5.4 it was observed that there was only one area that the learners (nationally and School D) performed well in namely: scientific notation. It was also observed that Geometry, square roots and cube roots, all operations on fractions, binomials and quadratic equations were areas where learners did not perform well. It was especially Geometry and fractions that were a point of concern seeing that these topics were addressed in the Intermediate Phase. This supports the view of the teachers in the interviews where they stated that the knowledge bases in Mathematics of learners coming from the Primary school were not sufficient (cf. 5.5.2.3).

The following figure shows the National performance of Grade 9 learners (average %) in the different content areas.

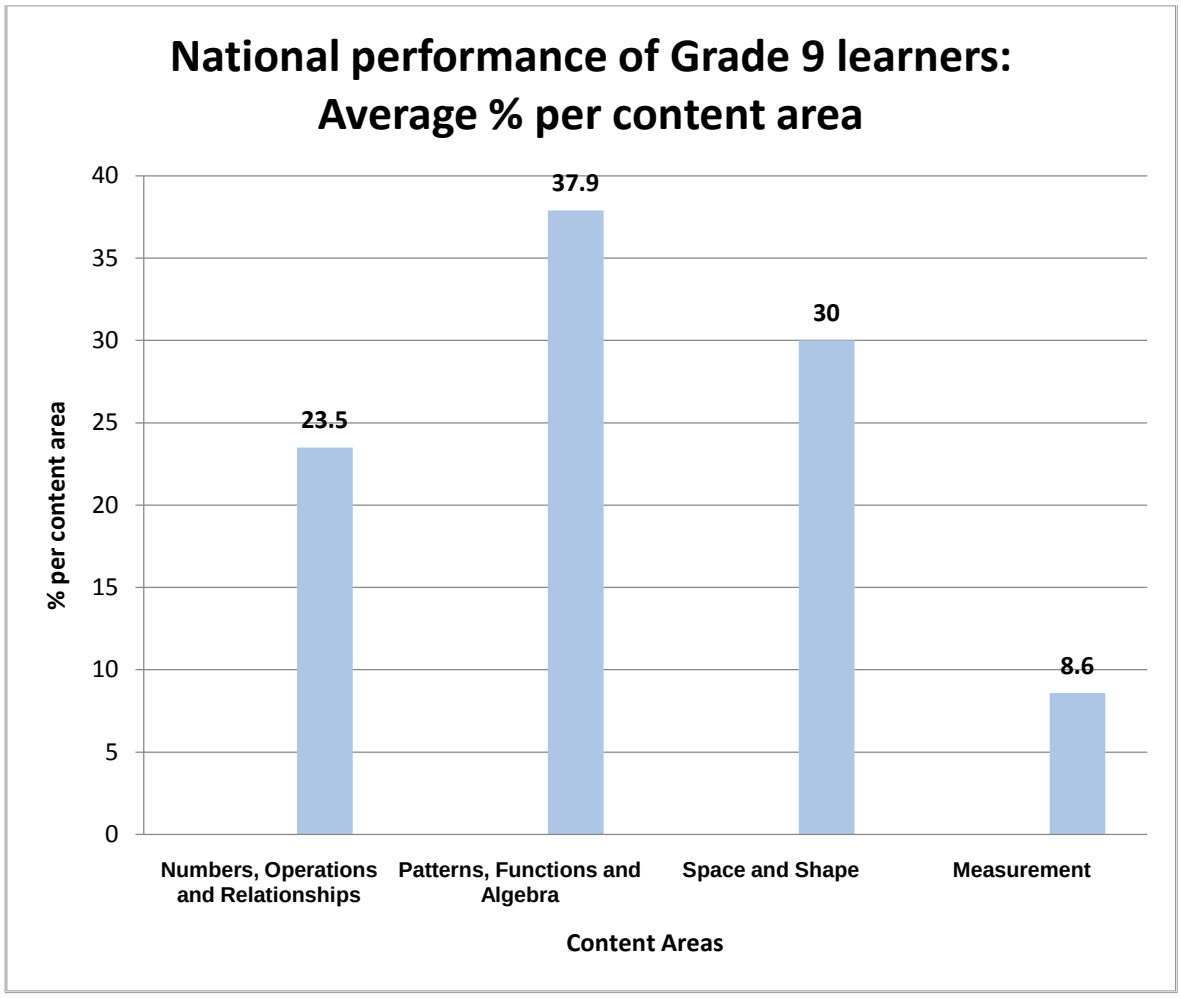

Figure 5.1: National performance of Grade 9 learners: Average % per content area

DBE (2014a: 54)

It is evident from Figure 5.1 that Grade 9 learners (national) experienced difficulty in answering questions on 'Measurement'. The second area learners experienced difficulty in was 'Numbers, Operations and Relationships'. It is further evident that the average percentage of 'Patterns, Functions and Algebra' and 'Space and Shape' were still very low but higher than the average percentages in 'Numbers, Operations and Relationships' and 'Measurement'.

To compare the content areas of the DBE and that of School D as listed above, the researcher categorized the questions of the ANA 2014 test as follows:

- Questions 1, 2, 8 and 12: Numbers, Operations and Relationships.
- Questions 3 to 7: Patterns, Functions and Algebra.
- Questions 9 and 10: Space and Shape.
- Question 11: Measurement.

The ANA 2014 test is attached in Appendix G (see Table E).

The following figure shows the performance of Grade 9 learners (average %) in School D in the various content areas:

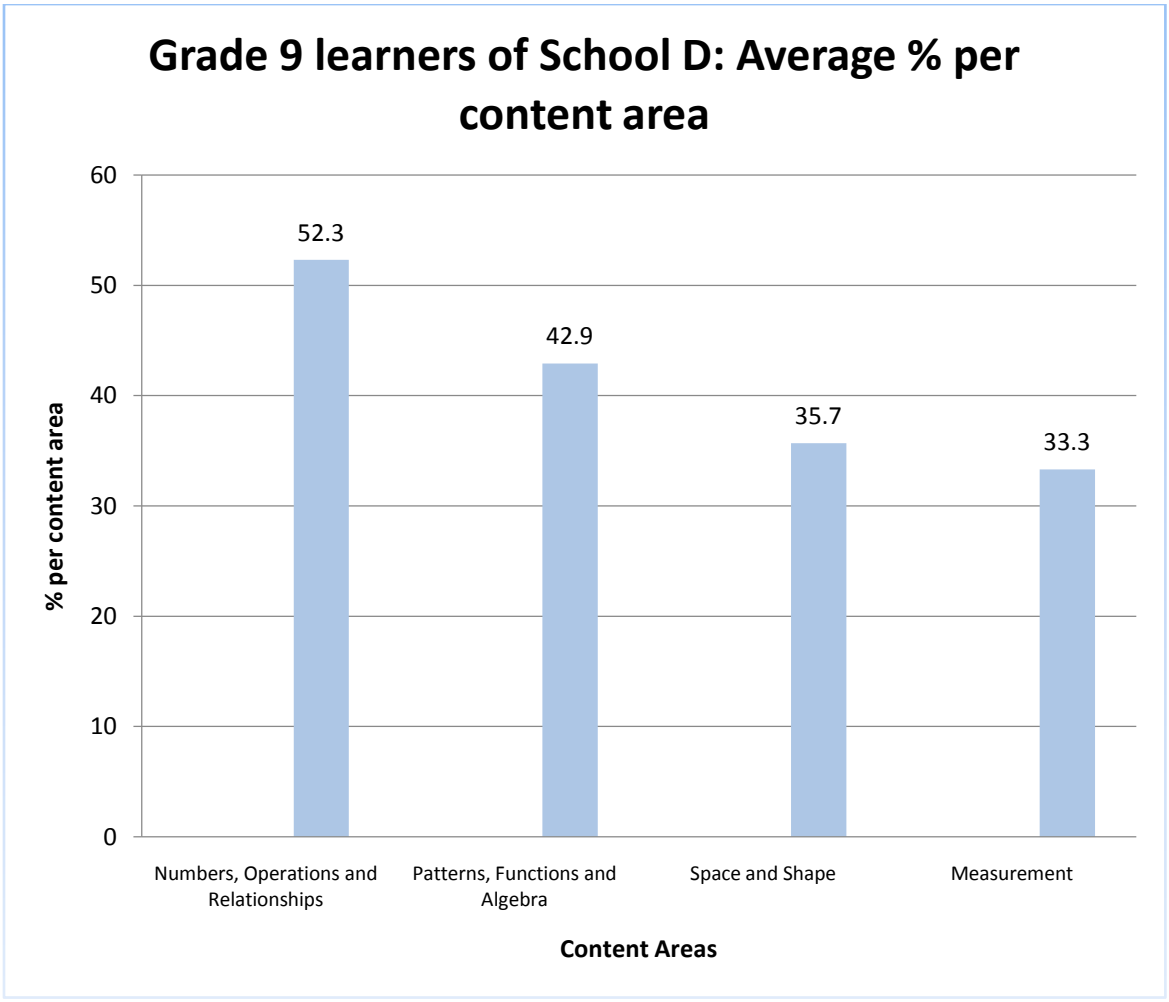

Figure 5 2: Grade 9 learners of School D: Average % per content area

From the above figure, the researcher observed that in questions on 'Space and Shape' and 'Measurement', the learners of School D experienced the most difficulties. Learners of School D performed better in questions on 'Numbers, Operations and Relationships' and 'Patterns, Functions and Algebra'. The performance of the learners in School D on 'Patterns, Functions and Algebra' was still weak seeing that the average is below 50%.

Overview

When comparing Figure 5.1 and 5.2, the researcher observed that the performance of learners nationally in all areas was below 50%. The performance of learners in 'Numbers, Operations and Relationships' of School D was just above 50% but still low (below 50%) in 'Patterns, Functions and Algebra'. 'Numbers, Operations and Relationships' include operations like fractions. This topic was dealt with in the Intermediate Phase. As stated previously, this supported the view of the teachers in the interviews where they highlighted their concern about the knowledge base in Mathematics of Grade 9 learners coming from the Primary school (cf. 5.5.2.3). From Table 5.1 and 5.2 the researcher also noticed that the total performance of School D was better than the learners nationally but it was only in the area 'Numbers, Operations and Relationships' that they performed on average better than the 50%.

From the focus-group interviews (cf. 5.5.2.1; 5.5.3.2) conducted with the learners the learners stated that according to them the ANA test was difficult. According to most of the learners the ANA 2014 test was of higher standard and the level of questions was not the same as the questions in their schools test/examination paper. The analysis of data obtained from the Diagnostic Reports nationally and School D supported the data obtained from the teachers and the learners, as the analysis of the Diagnostic Reports showed that learners had numerous areas of weaknesses.

5.6.2 Analysis of the test/examination papers

Several existing taxonomies, such as Bloom's Taxonomy (cf. 3.9), formulated cognitive levels at which learners must be able to perform (Anderson & Krathwohl 2001:31; Gall 1970:707-721).

The Curriculum and Assessment Policy Statement (CAPS) (DBE 2011:155) was introduced in 2011 and implemented from 2012 to 2014. They highlighted effective and cognitive goals for Mathematics learning. This analysis on the test/examination papers is situated in the cognitive domain of Mathematics teaching, learning and assessment. The curriculum requirements of ascribing cognitive levels in assessment are therefore important (DBE 2011:157).

Mathematics is a complex subject which requires an intricate process of teaching and learning (Usiskin 2012:502-521), such as understanding the various mathematical representations, the properties of mathematical concepts, and the application of operations within certain problems and the understanding of algorithms or methods (cf. 3.9). According to these dimensions of understanding, assessment would therefore need to be articulated, in addition to the levels of understanding proposed by Anderson and Krathwohl (2001:31).

Apart from the different areas in Mathematics, the CAPS document also describes four cognitive levels at which assessment has to be conducted. These levels are: Knowledge (25%), Routine Procedures (45%), Complex Procedures (20%) and Problem Solving (10%) (See Table 3.3) (DBE 2011:157).

The following table ascribes the adapted Bloom's taxonomy (2002) and CAPS (2011) cognitive levels.

Table 5.5: Cognitive levels of Bloom's adapted taxonomy and CAPS

	Bloom's adapted taxonomy 2002	CAPS 2011
Lower Order Thinking 	**Remembering** The learner recalls and repeats what was learned	**Knowledge** Estimate and appropriate rounding of numbers, straight recall, use of correct formula, use of Mathematical facts, appropriate use of Mathematical vocabulary
	Understanding The learner explains something in his or her own words	**Routine Procedures** Perform well-known procedures, simple applications and calculations derivation from given information, use of correct formula. Generally similar to those encountered in class
	Applying The learner applies concepts and frameworks	**Complex Procedures** Complex calculations or higher order reasoning; investigates elementary axioms to generalize them into proofs for straight line geometry, congruency and similarity, no obvious route to the solution; connections between different representations, conceptual understanding
	Analyzing The learner deconstructs a phenomenon into its component parts	**Problem Solving** Unseen, non-routine problems, higher order understanding and processes, break the problem down into its constituent parts
	Evaluating The learner renders a judgement of a phenomenon based on learned criteria	
Higher Order Thinking	**Creating** The learner creates something new by synthesizing what he or she has learned	

Lower level questions or fact questions are those concerning remembering subject matter or the recalling of facts. Higher level learning questions are those requiring the learners to analyze, evaluate or create.

Although it is challenging to always place questions on the exact cognitive levels, the researcher did an analysis on the test/question papers of the five sample schools in the research as well as an analysis on the ANA 2014 test paper. The Remembering level of the adapted Bloom's taxonomy corresponds with the cognitive level of Knowledge of the CAPS. The Understanding level of the adapted Bloom's taxonomy corresponds with the cognitive level of Routine Procedures of the CAPS. The Applying level of the adapted Bloom's taxonomy corresponds with the cognitive level of Complex Procedures of the CAPS. The last three levels of the adapted Bloom's taxonomy namely Analyzing, Evaluating and Creating correspond with the cognitive level of Problem Solving of the CAPS.

The researcher decided to use the cognitive level of the CAPS document in the analysis of the test and examination papers seeing that these levels correspond to the cognitive levels of the adapted version of Bloom's taxonomy as illustrated in Table 5.5. The test/examination papers of School A, B, D and E are attached in Appendix G of this research study. School C was not able to present their test/examination papers of September 2014.

In order to ascertain and describe the distribution of questions on the various cognitive levels of School A, the data were compared to prescribed percentages at the different cognitive levels of the CAPS document (see Table 3.3).

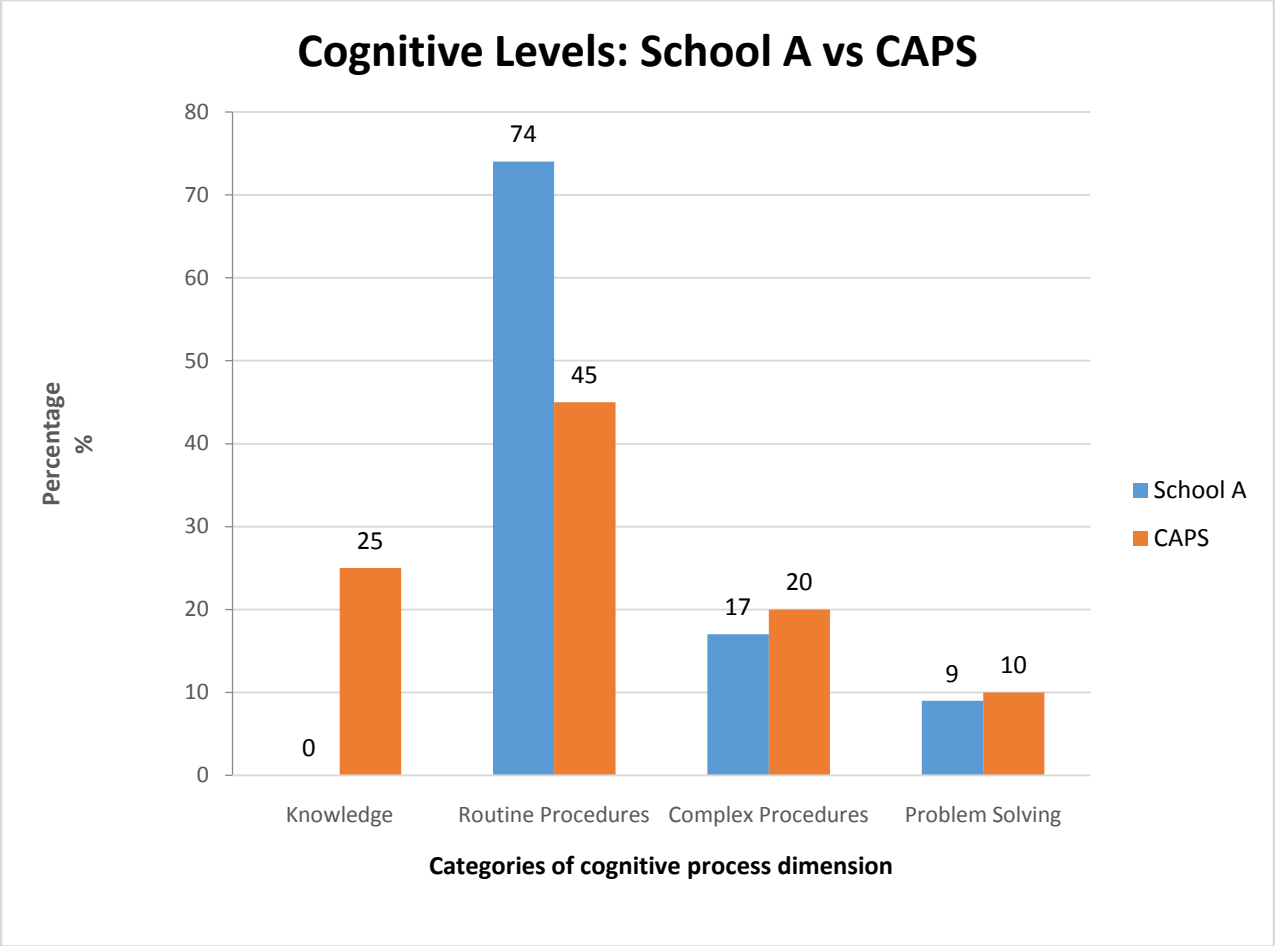

Figure 5.3: Cognitive Levels: School A versus CAPS

From the above figure it is evident that the questions in the test/examination paper of School A had an uneven distribution when compared with the cognitive levels of the CAPS.

- Knowledge: No questions at this cognitive level were included in the paper of School A in comparison with the prescribed percentage in the CAPS document.
- Routine Procedures: There were 29% more questions at this cognitive level of School A when compared to the prescribed percentage in the CAPS document.

- Complex Procedures: Questions at this cognitive level of School A were more or less the same as the prescribed percentage in the CAPS document.
- Problem Solving: Questions of this cognitive level were relatively the same compared to the prescribed percentage in the CAPS document.

The following graph shows the analysis of the various cognitive levels of School B compared to the prescribed percentages at the different cognitive levels of the CAPS document.

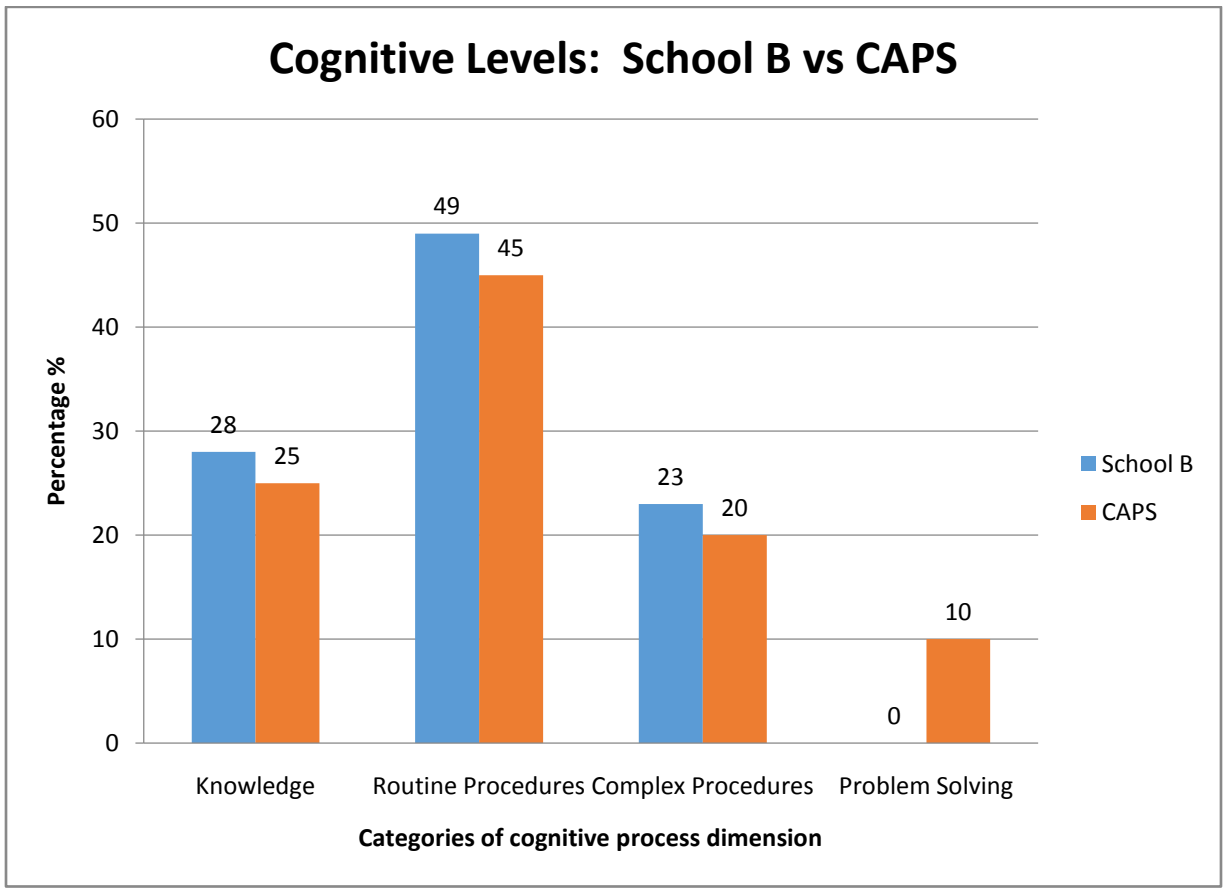

Figure 5.4: Cognitive Levels: School B versus CAPS

From the above figure it is evident that the questions in the question paper of School B had an uneven distribution according to the cognitive levels of the CAPS.

- Knowledge: Questions on this cognitive level were more or less similar to the prescribed percentage in the CAPS document.
- Routine Procedures: Questions on this cognitive level were more or less the same in comparison with the prescribed percentage in the CAPS document.
- Complex Procedures: Questions on this cognitive level were relatively the same compared to the prescribed percentage in the CAPS document.
- Problem Solving: School B had no questions on this cognitive level when comparing it to the prescribed percentage in the CAPS document.

The following figure shows the cognitive levels of School D compared to the prescribed percentages at the different cognitive levels of the CAPS document.

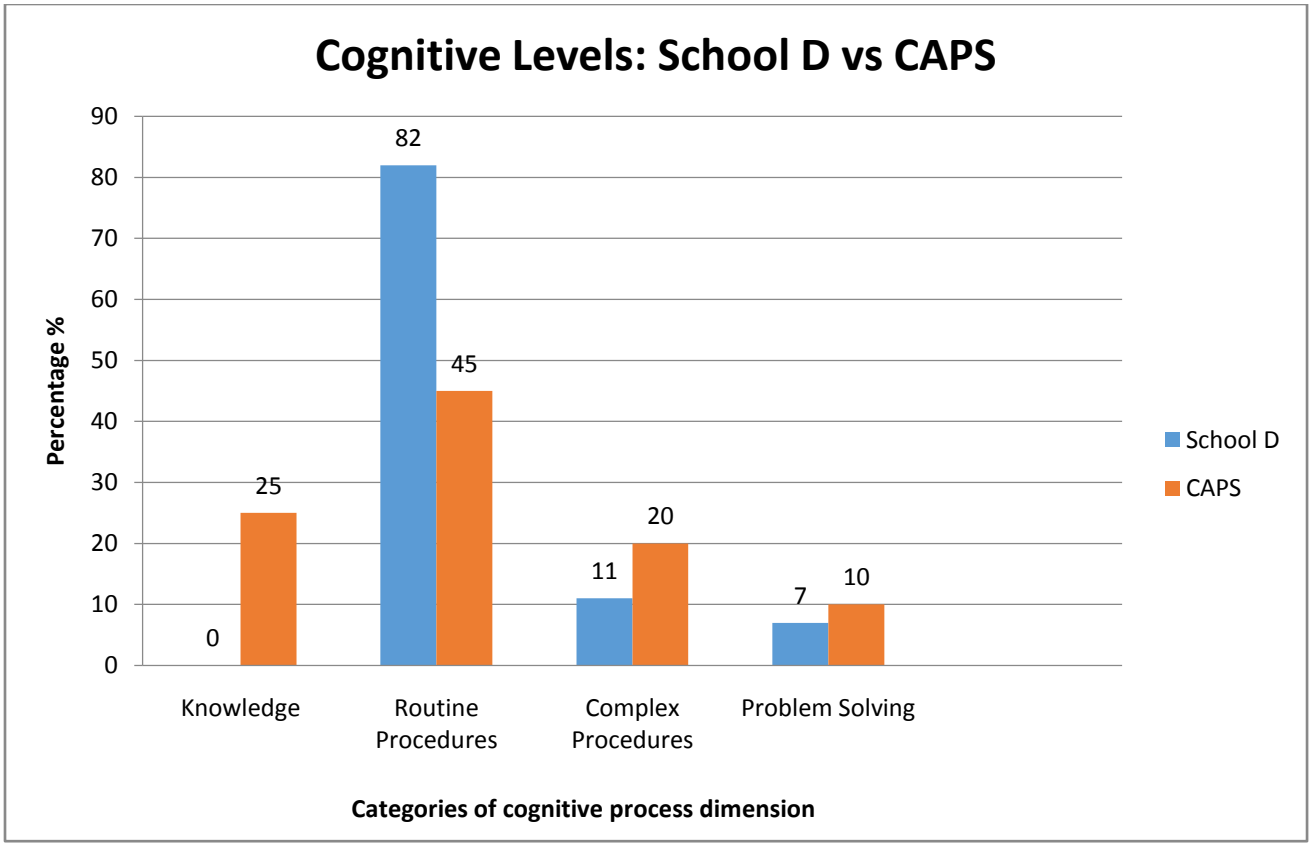

Figure 5.5: Cognitive Levels: School D versus CAPS

It is evident from Figure 5.5 that the cognitive levels of School D were unevenly distributed.

- Knowledge: School D had no questions on this cognitive level when comparing it to the prescribed percentage in the CAPS document.
- Routine Procedures: There were 37% more questions on this cognitive level of School D in comparison with the prescribed percentage in the CAPS document.
- Complex Procedures: There were 9% less questions on this cognitive level of School D when comparing it to the prescribed percentage in the CAPS document.
- Problem Solving: Questions of this cognitive level were more or less the same in comparison with the prescribed percentage in the CAPS document.

The following graph shows the analysis of School E's cognitive levels compared to the prescribed percentages at the different cognitive levels of the CAPS document.

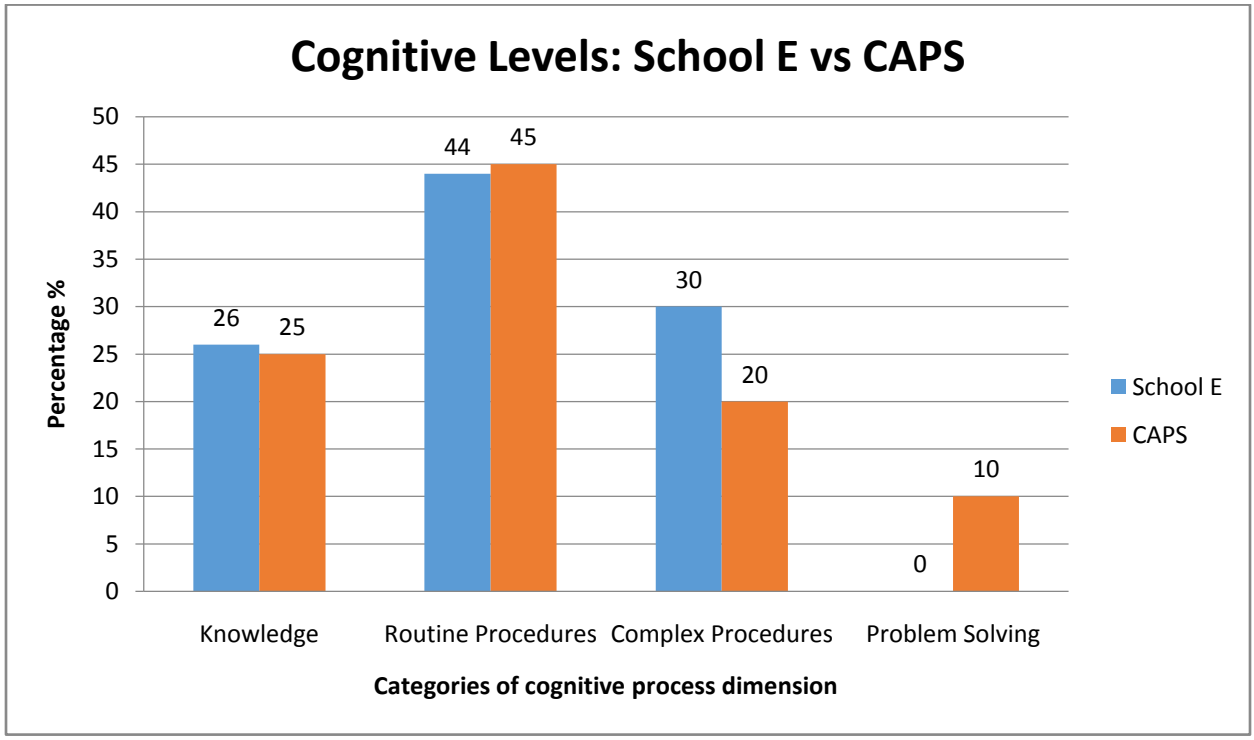

Figure 5 6: Cognitive Levels: School E versus CAPS

Based on the data in Figure 5.6, the distribution of the questions in the test paper of School E was unevenly distributed.

- Knowledge: Questions on this cognitive level were comparatively the same as the prescribed percentage in the CAPS document.
- Routine Procedures: Questions on this cognitive level in the test/examination paper of School E were more or less the same in comparison with the prescribed percentage in the CAPS document.
- Complex Procedures: School E had 10% more questions on this cognitive level when comparing it to the prescribed percentage in the CAPS document.
- Problem Solving: There were no questions on this cognitive level in School E's paper when comparing it to the prescribed percentage in the CAPS document.

The following table shows the analysis of the cognitive levels of the ANA 2014 test paper and was compared to the prescribed percentages at the different cognitive levels of the CAPS document.

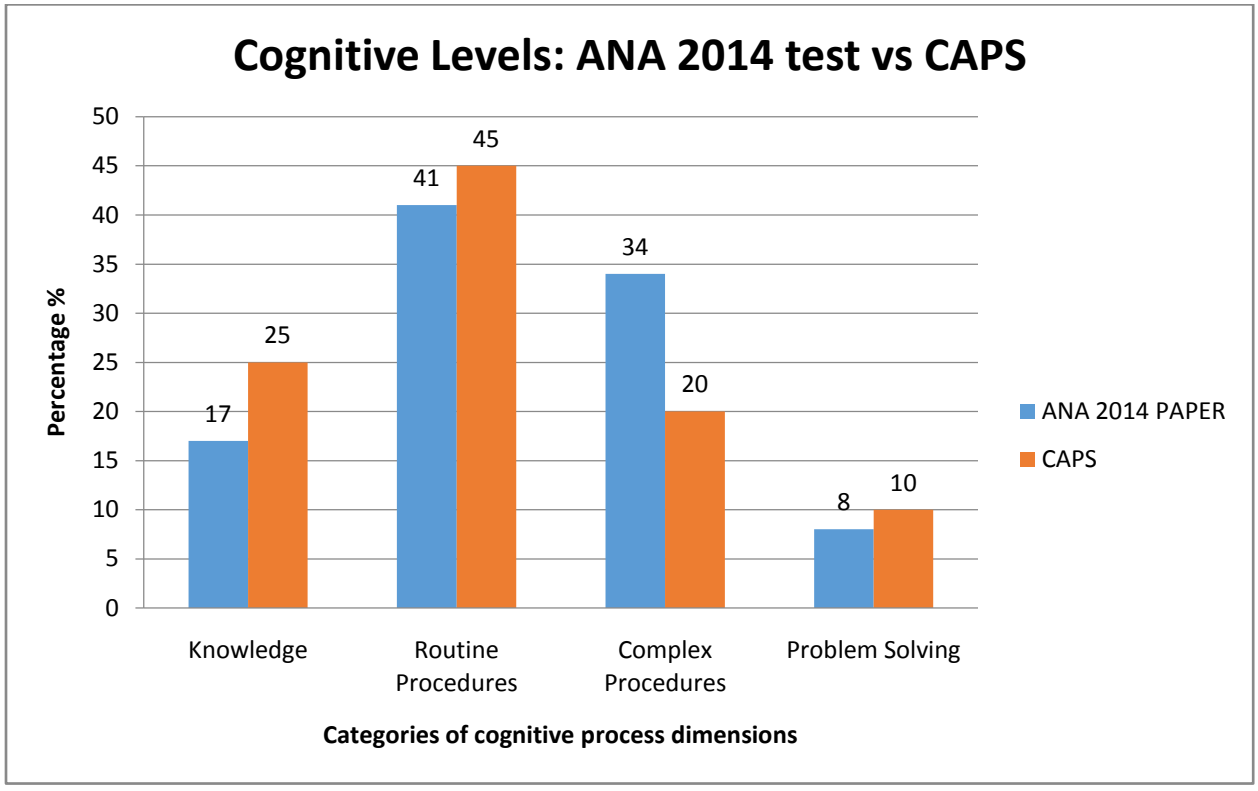

Figure 5.7: Cognitive Levels: ANA 2014 test versus CAPS

When observing Figure 5.7 regarding the cognitive levels the following were found:

- Knowledge: There were 8% less questions on this cognitive level in the ANA 2014 test when compared to the prescribed percentage of the CAPS document.
- Routine Procedures: Questions on this cognitive level in the ANA 2014 test where more or less the same in comparison with the prescribed percentage in the CAPS document.
- Complex Procedures: There were 14% more questions on this cognitive level of the ANA 2014 test compared to the prescribed percentage in the CAPS document.
- Problem Solving: Questions on this cognitive level were more or less the same in the ANA 2014 test comparing to the prescribed percentage in the CAPS document.

In Figure 5.8 the data displayed in Figures 5.3 to 5.7 were displayed in a single graph to indicate comparisons.

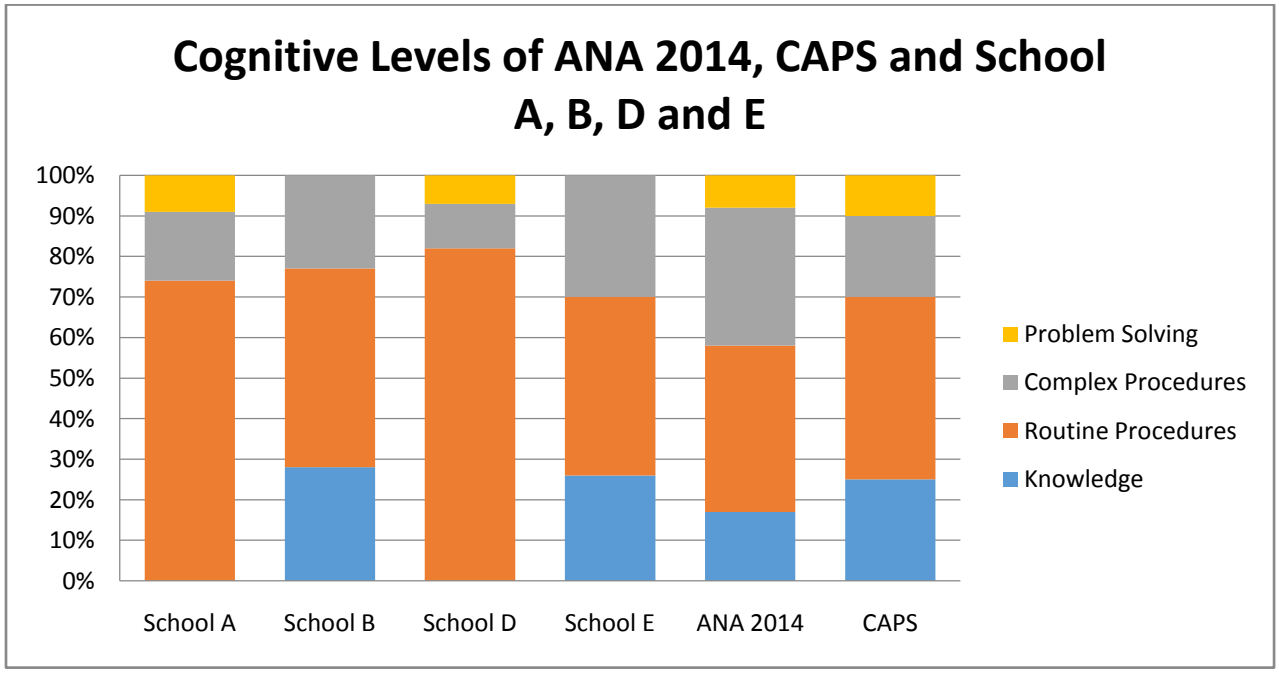

Figure 5.8: Cognitive Levels of ANA 2014, CAPS and School A, B, D and E

From this combined graph it can be deduced that School A and D asked too many questions on the level of Routine Procedures and no questions on the level of Knowledge. It can further be deduced that Schools B and E asked no questions on the higher order thinking level of Problem Solving, implying that problem solving was not assessed in these schools. It is further evident that the ANA test complied the most with the prescriptions of the CAPS document regarding assessment at various levels.

Overview

Only school A and D had questions on the higher level of thinking namely Problem Solving. Teachers B and E highlighted that tests/examinations in their schools are set with the intention to pass the average learner (cf. 5.5.3.1). It can thus be assumed that some teachers concentrated on factual answers that had little to do with developing higher level thinking that could provide learners with opportunities to practice Mathematics and answer higher level questions. There was a more even distribution of questions in the ANA 2014 test.

When observing the data conducted during the interviews with the teachers (cf. 5.5.3.2) the majority of teachers mentioned that the ANA 2014 test tested the full range of knowledge of a Grade 9 Mathematics learner (with the exception of Teacher E). Unlike, in the interviews with the learners (cf. 5.5.3.2; 5.5.2.1) they experienced the ANA 2014 test as difficult and that the level of questions was of a higher standard as their school's test/examination paper. Most (Schools A and D) of the test/examination papers of the sample schools did not have questions on the higher level of thinking namely Problem Solving. This might be the reason why learners experienced the ANA 2014 test as difficult.

Grade 9 is the final phase of the GET. As from Grade 10 learners can choose between Mathematics and Mathematical Literacy. The main purpose of the teachers interviewed (Teacher B and E) were to make sure that the learner passes Grade 9 and tests/examinations papers are set in line so that the average learner can pass (cf. 5.5.3.1). This may possibly be the reason why questions on the higher level of thinking namely Problem Solving were not assessed in the test/examination papers of the sample schools.

5.6.3 Document analysis on the test/examination results

The following figure displays the results (averages) of learners in the ANA 2014 test and the results (averages) of the learners in the September 2014 test/examination of the sample schools.

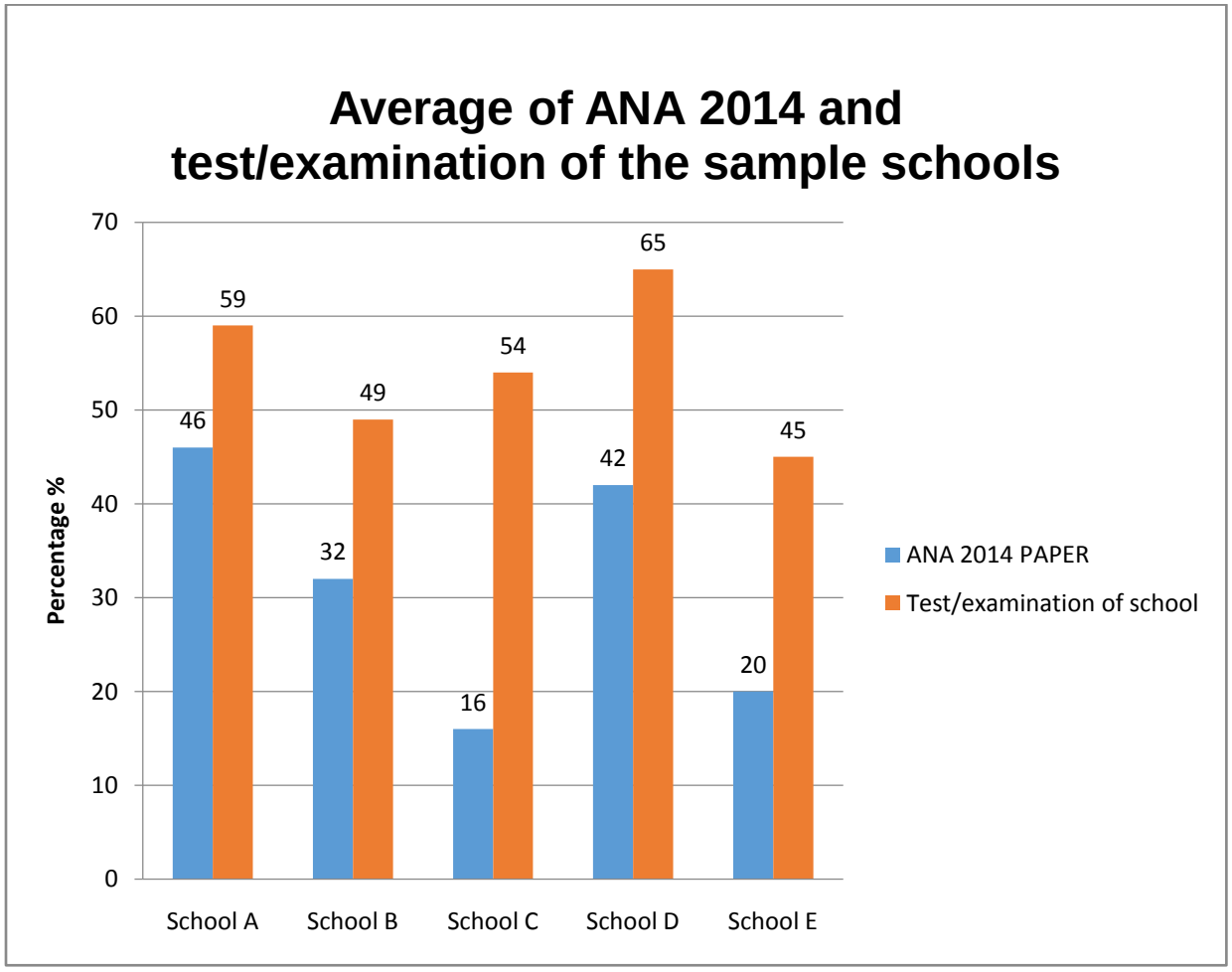

Figure 5.9: Average of ANA 2014 and test/examination of the sample schools

From Figure 5.9 it can be assumed that all learners performed better in the test/examination of their school compared to the ANA 2014 test. Learners in School A performed 13% better in their school's test/examination than in the ANA 2014 test. Learners in School B performed almost 20% better in their school's test/examination than in the ANA 2014 test. Learners in School C performed almost 40% better in their school's test/examination compared to the ANA 2014 test. Learners of School D and E

performed more or less 25% better in their test/examination of their school in comparison with the ANA 2014 test. In the focus-group discussion, the researcher sourced information on learners' opinions of the ANA 2014 test. Most of the learners reflected that they did not learn for the ANA for the reason that it did not count on their reports (cf. 5.5.3.1). It was also confirmed by the teachers in their interviews that the ANA test will be more powerful if it counts towards the grading of learners (cf. 5.5.3.1). The data obtained from the interviews with the teachers, supported the data obtained from the interviews of the learners and the results of the ANA 2014 test.

5.7 SUMMARY

In this chapter the researcher strived to answer the question: "To what extent the ANA has an influence on teaching, learning and assessment in a Grade 9 Mathematics classroom"? The data obtained in Chapter 5 are in relation with the literature study in Chapters 2 and 3.

In this chapter empirical research was conducted to address the following objectives: to explore and describe to what extent the ANA has influenced the teaching of Mathematics in a Grade 9 Mathematics classroom; examine the influence that the ANA has on the learning of Mathematics in a Grade 9 Mathematics classroom; explore if the ANA has an influence on assessment in a Grade 9 Mathematics classroom; explore if the implementation of the ANA is in alignment with the intention of the designers of the ANA 'project' and to formulate recommendations and future research possibilities. The data obtained from the interviews and document analyses were triangulated. The main themes identified from the interviews were: teaching, learning and assessment.

Chapter 6 presents the findings, conclusions, recommendations and a summary.

CHAPTER 6

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

It always seems impossible until it's done.

Nelson Mandela

6.1 INTRODUCTION

In concluding this study, Chapter 6 provides a general overview in order to demonstrate that the aims highlighted in Chapter 1 have been addressed and achieved.

The overarching aim of this study was to investigate the nature and extent of the influence of the ANA test on the Mathematics pedagogy in Grade 9 Mathematics classes.

In pursuing these aims the following objectives were formulated in an attempt to realize the over-arching aim:

- Explore and describe to what extent the ANA has influenced the teaching of Mathematics in a Grade 9 Mathematics classroom.
- Examine the influence that the ANA has on the learning of Mathematics in a Grade 9 Mathematics classroom.
- Explore if the ANA has an influence on assessment in a Grade 9 Mathematics classroom.
- Explore if the implementation of the ANA is aligned with the intention of the designers of the ANA 'project'.
- To formulate recommendations and future research possibilities.

In this concluding chapter, the researcher summarizes the findings, discusses the interpretation of the results, and presents the conclusions and recommendations that relate to the literature and the empirical investigation in respect of the research aim and objectives.

6.2 SUMMARY OF CHAPTERS

In Chapter 1 the aim and objectives of this study were stated (cf. 1.3). The research methodology (cf. 1.4), data analysis (cf. 1.5), ethical issues (cf. 1.6) and the layout of the chapters (cf. 1.9) were also explained briefly in this chapter.

To gain deeper understanding on the above objectives in general and more specifically on the teaching and learning of Mathematics the focus of Chapter 2 was on the cognitive learning theories of Piaget, Vygotsky, Kolb and De Corte, and also the social and cognitive theories of knowledge of Durkheim, Bernstein, Bandura and Young. The work of Shulman, Ball and the MAKER framework helped to gain understanding of pedagogy.

ANA tests are assessment activities and it was necessary to gain a deeper understanding of how it has influenced teaching, learning and assessment in the Mathematics classroom. The third objective guided the literature study in Chapter 3. In this chapter assessment, the importance of feedback and alignment were interrogated. The rationale and the purpose of the ANA as well as the adapted version of Bloom's taxonomy were also examined in Chapter 3. This was necessary to identify criteria for evaluating assessment. The literature studies in the two chapters provided a framework from which the researcher constructed the interview guide (see Appendix A and B).

Chapter 4 discussed and explained the approach and design of the study, the sampling procedures, data gathering instruments, data analysis, validity, reliability, trustworthiness and ethical guidelines. The aim was to investigate the nature and extent of the influence of the ANA test on the Mathematics pedagogy in Grade 9 Mathematics classrooms. It was highlighted that the aim of this research was to examine how teachers and learners experience the ANA test written in September 2014. It was explained why a qualitative research method was chosen to conduct this research and it

was also clarified why semi-structured interviews, focus-group interviews and document analyses were used as instruments to gather data.

In Chapter 5 the first four objectives were further investigated. This chapter focused specifically on the data collected at the five sample schools. The participants who were interviewed were five Grade 9 Mathematics teachers at specific schools. Learners at these schools were also interviewed in focus-groups (cf. 5.5.1; 5.5.2; 5.5.3). Various documents were analyzed namely: the Diagnostic Reports of the DBE and of Teacher D; the analysis on the ANA 2014 test and the September 2014 test/examination of the sample schools and the results of the ANA 2014 test and the September 2014 test/examination of the sample schools (cf. 5.6.1; 5.6.2; 5.6.3).

In this chapter the findings will be summarized where after the fifth objective and conclusions will be executed.

6.3 FINDINGS AND CONCLUSIONS

Empirical research findings were a result of a data-triangulation process, whereby data from the semi-structured interviews were triangulated. Literature from Chapter 2 and 3 were also used to support and/or understand the outcomes of the empirical study.

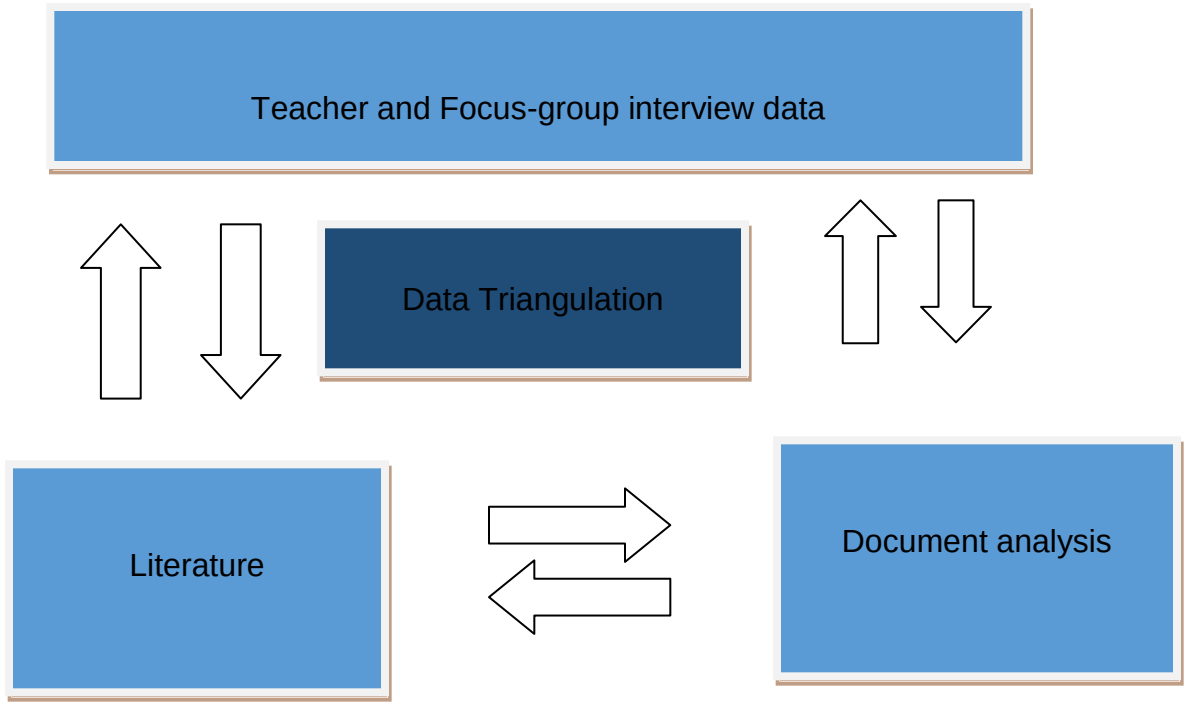

Figure 6.1: Triangulation applied in this study

The findings were analyzed for each of the following themes: teaching, learning and assessment. The following section describes the findings of the research study.

6.3.1 The ANA and the teaching of Mathematics in a Grade 9 Mathematics classroom

The first objective was to explore and describe to what extent the ANA has influenced the teaching of Mathematics in a Grade 9 Mathematics classroom.

6.3.1.1 Findings

Effective teaching depends on sufficient preparation (cf. 2.3.5; 2.3.6). Mwamwenda (1995:505) asserted that in order for teachers to be effective they should ensure that they prepare well for their lessons. All teachers involved in the study taught Grade 9 Mathematics learners according to the syllabus prescribed by the DBE (cf. 5.5.1.1). In order to prepare learners for the ANA test, teachers handed out papers of the previous years (ANA 2012 & 2013). Teacher E also included multiple choice questions in their

own test/examination papers and Teacher C summarized the work schedule for learners so that learners were more comfortable with multiple choice questions (cf. 5.5.1.1).

Most of the teachers (Teacher A, B and D) interviewed taught according to the Grade 9 syllabus and did not focus on the ANA as such (except Teacher C). They incorporated the ANA as a part of their teaching. Since this was the attitude of the teachers, the learners' responses towards the ANA were negative. One teacher did however adapt his teaching to enable learners to pass tests (ANA) with less time spent on providing opportunities for learning.

Although only Teacher C and E stated that they felt the pressure of ANA to complete the syllabus in time before learners wrote the tests in September 2014, the majority of teachers made extra time available (after school hours) for the learners to complete the Grade 9 syllabus (cf. 5.5.1.1). The Assessment Guidelines of the DBE are arranged in columns which state on which work the Grade 9 Mathematics learner will be tested in the ANA test (DBE 2015a:1-8). One of the teachers (Teacher E) interviewed experienced that the scope and volume of the syllabus is too wide. She senses uncertainty because the schedule of preparation for the ANA test is not defined. She feels that the content of the syllabus is too large for learners to handle (cf. 5.5.1.1; 5.5.3.2).

Each of the teaching approaches has its own MAKER profile (cf. 2.4). Based on the interviews with the teachers, the researcher found similarities with the MAKER framework. The main purpose (Ends) of the teachers interviewed was to make sure that the learners pass Grade 9. All teachers interviewed prepared (Method) the Grade 9 learners according to the prescribed syllabus of the DBE. Based on teachers' responses obtained from the interviews, it appeared that most of the teachers strongly focused on the Mathematical knowledge (Knowledge) needed to progress to Grade 10 (cf. 5.5.1.2).

Teachers need knowledge of content to inform their teaching practice (cf. 2.3.5; 2.3.6). Based on teachers' qualifications (see Table 5.1) the researcher believes that the subject-matter knowledge of the five teachers interviewed were of good quality. Teacher C and D have Mathematics one. Teacher B has Mathematics two and Teacher A and E

have Mathematics three (see Table 5.1). Although teachers indicated that they have adequate knowledge to teach Grade 9 level Mathematics there are also teachers (Teacher B and E) that are worried about the knowledge base of novice teachers entering the teaching profession (cf. 5.5.1.3).

6.3.1.2 Conclusion

Based on the question raised by the problem statement (cf. 1.2), the aim and objective of the research (cf. 1.3) were achieved.

The first objective was to explore and describe to what extent the ANA has influenced the teaching of Mathematics in a Grade 9 Mathematics classroom. This objective was achieved by means of the literature review in Chapter 2 and the interviews with teachers and learners.

From the above it can be concluded that the ANA had an influence on teaching in a Grade 9 Mathematics classroom. More and more time is needed after school hours to compensate the work schedule for the Grade 9 Mathematics syllabus. Constant invention and improvisation put pressure on teachers. Teachers' choice of words is in itself illuminating. References to 'making extra lessons', 'pushing on the afternoon', 'Saturday you have to bring learners for extra class', 'summary of that chapter', 'vierde kwartaal-take in derde kwartaal doen', 'Wiskunde-dag' (cf. 5.5.1.1), all convey a sense of being pressurized in which there is little or no professional reward. Thus, teachers were pressurized to complete the work schedule before the ANA test was written in September 2014. It can further thus be concluded that the Mathematics curriculum is too 'overloaded'.

Most of the teachers interviewed did not focus on the ANA as such, they continued with the syllabus. It can be concluded that teachers had a negative attitude towards the ANA and this negative perception streamed down towards the learners (cf. 5.5.1.1). It can be concluded that only one teacher focused on learners passing the ANA tests, while the rest focused primarily on improving overall learning achievement.

Teachers interviewed followed an Executive teaching approach with emphasis on Method, Knowledge and to a certain extent Ends as pedagogical elements (cf. 2.4;

5.5.1.1; 5.5.1.2; 5.5.1.3). The teacher as an Executive places emphasis on Method (methods of teaching) and Knowledge (knowledge of subject matter). Since the main purpose (Ends) of teachers interviewed was to make sure (Method) that the learners pass Grade 9 and therefore focused on the Mathematical knowledge (Knowledge) needed to progress to Grade 10. The elements Awareness and Relationship as well as noble Ends were not evident.

A further conclusion was that the subject-matter knowledge of the five teachers interviewed is adequate to teach Grade 9 Mathematics (see Table 5.1). Teachers interviewed studied Mathematics at a post-matric level and all teachers are appropriately qualified to teach Mathematics in GET phase. Teacher A, B and E have Mathematics two or three, thus they are qualified to teach Mathematics in the FET phase. There is concern though regarding the knowledge of Mathematics on certain sections of the Grade 9 syllabus of novice teachers.

6.3.2 The ANA and the learning of Mathematics in a Grade 9 Mathematics classroom

The second objective was to examine the influence that the ANA has on the learning of Mathematics in a Grade 9 Mathematics classroom.

6.3.2.1 Findings

The findings of the qualitative investigation (interviews with the teachers and learners as well as the analysis of the Diagnostic Report of the DBE and Teacher D) were presented and integrated with the findings of the literature study.

Based on the interviews with the learners in the focus-groups, most of the learners saw Mathematics as a ‘subject to understand’ and not as a ‘learning subject’. The majority of learners mentioned that they didn’t learn Mathematics. Furthermore, the ANA provided a better basis for learners to decide what subjects they should take in Grade 10 to 12. Thus, the ANA provided them to choose between Mathematics and Mathematical Literacy (cf. 5.5.2.1).

Based on the teachers' and learners' responses obtained from the interviews, it appeared that most of the learners, who took part in this research, saw the ANA as unimportant. The learners indicated that they did not learn for the ANA as it did not count as a formal test mark on their report (cf. 5.5.3.1).

Effective feedback leads to successful learning (cf. 3.6). Based on the teachers' (cf. 5.5.2.2) responses obtained from the interviews, it appeared that most of the teachers (Except Teacher D), revised the ANA 2014 test with the learners. Thus, there was evidence that descriptive and/or evaluative feedback took place. The majority of the learners stated that the only feedback they received were their marks, no memorandum was given to them and they did not re-do the ANA 2014 test (cf. 5.5.2.2). The views of teachers and learners in the focus groups were contradictory as to whether descriptive and/or evaluative feedback occurred. The reason for this might be that not all learners interviewed were taught by the teachers interviewed.

Since 2011, the DBE compiled a Diagnostic Report of the ANA results. These results of the ANA test are reported in table and narrative form (cf. 3.7). The purpose of the ANA Diagnostic Report is to inform the learners, teachers, principals, management of curriculum implementation, management at district/circuit level and management at national and provincial levels to implement suitable interventions to improve the quality of teaching and learning in basic education (DBE 2014a:4). Two of the teachers (Teacher C and E) received the Diagnostic Report of the ANA from the Department and used it to inform the learners of their weak points and strong points. Teacher E did not physically analyze the Diagnostic Report but did an error analysis on her learners' ANA 2014 test (cf. 5.5.2.2). The other teachers were not aware of a Diagnostic Report that was sent from the Department to the school. One of the teachers (Teacher D) compiled her own Diagnostic Report. This Diagnostic Report was compared to the Diagnostic Report of the DBE of learners nationally. From the data obtained from the analysis on the Diagnostic Report of Teacher D and the DBE it appeared that there were more areas of weakness in the Diagnostic Report of learners nationally than areas of weakness of School D. School D had more strong areas than the learners nationally (cf. 5.6.1).

Learners' current knowledge and level of understanding should be the starting point of all teaching. Learners need knowledge to understand and interpret the world. Without knowledge learners remain dependent on those who have knowledge (cf. 2.2.4; 2.3.3; 2.3.5). Teacher A revealed that the Grade 9 learners' knowledge was satisfactory. Teachers were concerned that the average Grade 9 learner do not have appropriate knowledge (Teachers B, D and E) and that the 'gap' in Mathematical knowledge (Teachers A, B and D) of the Grade 9 Mathematics learner emerges from the Primary school (cf. 5.5.2.3). From the analysis of the Diagnostic Report of the DBE and of Teacher D (cf. 5.6.1), it was observed that there were several areas of weakness in learners. It was especially fractions and geometry which were areas of concern seeing that both topics were addressed in the Intermediate Phase.

6.3.2.2 Conclusion

The second objective, namely to explore if the ANA has an influence on the learning of Mathematics in the Grade 9 Mathematics classroom, was achieved by means of the literature review conducted in Chapter 2 and 3, interviews with teachers and learners of the five sample schools and the document analysis of the Diagnostic Reports of the DBE and Teacher D.

In summary this conclusion flows from the following findings discussed above.

What Grade 9 learners learned from the ANA helped them decide to choose between Mathematics and Mathematical Literacy in Grade 10 to12 (cf. 5.5.2.1).

Feedback on the ANA 2014 test was questionable (cf. 5.5.2.2). Because of this, various shortcomings were identified regarding feedback on the ANA. It appeared from the learners' responses that feedback was not in line with the literature study (cf. 3.6). Thus it can be concluded that the majority of learners did not receive evaluative and/or descriptive feedback for the purpose of strengthening teaching and learning. It can also be concluded that the majority of teachers did not receive the Diagnostic Report from the DBE and therefore could not assist learners with proper feedback on areas of weakness and areas of strength (cf. 5.5.2.2). Thus the lack of feedback and teachers

not using the Diagnostic Reports affected learning in Grade 9 Mathematics. Learners could not engage with questions which they had wrong or partly wrong.

Linking new knowledge with learners' existing knowledge can affect the process and outcomes of learning. Mathematics instruction should build on learners' existing knowledge along with the teaching of computational algorithms. This is because learners often possess relevant information that can assist them in mastering new content (cf. 2.2.4; 2.3.3). From the analysis of the Diagnostic Reports (DBE and Teacher D) (cf. 5.6.1) it can be concluded that some Grade 9 Mathematics learners did not have sufficient knowledge (Teachers B, D and E) (cf. 5.5.2.3). This is also in line with the view of teachers that some Grade 9 learners coming from the Primary school (Teachers A, B and D) did not have sufficient Mathematics knowledge (Teachers B, D and E) (cf. 5.5.2.3). Thus prior knowledge and the challenge to finish the ANA didn't give teachers the time to fill the 'gap' so that learners can really learn.

6.3.3 The ANA and assessment in a Grade 9 Mathematics classroom

The third objective was to explore if the ANA has an influence on assessment in a Grade 9 Mathematics classroom.

6.3.3.1 Findings

The findings of the teachers and focus group interviews with learners; the analysis of the September 2014 test/examination of the five sample schools and the ANA 2014 test; the results of the test/examination of September 2014 of the five sample schools and the ANA 2014 test were presented and integrated with the findings of the literature study.

From the study it was concluded that the ANA did not influence any assessment in a Grade 9 Mathematics classroom. Teachers assessed the learners as usual with formal tests, informal tests, assignments, projects and tutorials (cf. 5.5.3.1).

The teachers' interview responses revealed that the majority of the teachers (except Teacher E) experienced that the ANA 2014 was up to standard and tested the full range of knowledge of a Grade 9 learner. On the other hand Teacher E believed that the

standard of the ANA 2014 test was too high, some questions were not reasonable according to her and were on the level of a Grade 10 learner. She also highlighted that the average learner cannot cope with the amount of work (cf. 5.5.3.2). As mentioned earlier (cf. 6.3.2.1) learners did not value the importance of the ANA test. Learners did not learn for the ANA test since it did not count towards their grading (cf. 5.5.3.1). The learners also mentioned that the ANA 2014 test was difficult with 'tricky' questions which they could not master. According to the learners the ANA test was more difficult than the test/examination of their school (cf. 5.5.3.2). Although the learners experienced the ANA 2014 test as difficult they also stated that the ANA 2014 test showed them to look deeper into questions and that there is more than one way to solve a Mathematics problem (cf. 5.5.2.1). In the analysis of the results of test/examination of the sample schools compared to the ANA 2014 test it was found that learners performed better in their test/examination at their school (cf. 5.6.3).

Bloom's taxonomy provided a framework for determining and clarifying learning objectives. The analysis on the question papers (cf. 5.6.2) showed that the questions in the test/examination of most of the sample schools focused mainly on questions that tested Knowledge, Routine Procedures and Complex Procedures, in other words the lower order of thinking. Questions on Problem Solving rarely appeared in the test/examination of the sample schools. When comparing the distribution of the higher level cognitive question namely Problem Solving with the ANA 2014 test, School A and School D tested higher cognitive level questions in their test/examination. Teacher B and E mentioned that test/examination papers for the Grade 9 learners were set with the intention that the average learners pass Grade 9, since Grade 9 is the final stage of the GET phase (cf. 5.5.3.1). The analysis of the questions of the ANA 2014 revealed that all cognitive levels were tested. Learners interviewed (cf. 5.5.3.2) experienced the ANA test as difficult and the reason for this may be the fact that most of the schools in this research study did not test learners' higher cognitive level of thinking (cf. 5.6.2). The standard of the ANA test is standardized for Mathematics learners, but the average learner that struggled in Mathematics found it hard to cope with the ANA test (cf. 5.5.3.2). The document analysis on the results of the ANA 2014 test and the

test/examination of the sample showed that the learners performed better in their school's test/examination than in the ANA 2014 test (cf. 5.6.3).

6.3.3.2 Conclusion

This objective was achieved through empirical research by means of teachers' and focus-group interviews with learners; analysis of the test/examination papers of the sample schools and the ANA 2014 test and the analysis of the results of the test/examination of the sample schools and the ANA 2014 test.

Based on the literature review Bloom stated that the major purpose of constructing a taxonomy of educational objectives is to facilitate communication. According to Bloom the use of the taxonomy as an aid in developing a precise definition and classification of such vaguely defined terms as thinking and problem solving would enable teachers to discern similarities and differences among the goals of their different instructional programmes (cf. 3.9). The prescribed cognitive levels of the CAPS document describe four cognitive levels at which assessment has to be conducted. These levels are: Knowledge (25%), Routine Procedures (45%), Complex Procedures (20%) and Problem Solving (10%) (See Table 3.3) (DBE 2011:157). It is evident from the interviews with the learners that learners experienced the ANA test as difficult because the questions in the ANA test were different from the questions in their schools' test/examination (cf. 5.5.3.2). From the analysis of the test/examination papers (cf. 5.6.2), it can be concluded that not all of the sample schools tested all cognitive levels as prescribed by the CAPS document. Teachers concentrated on factual answers that had not much to do with developing creative thinking and skills that could provide learners with opportunities to answer higher level questions of thinking. It can be concluded that questions in the test/examination paper of most of the sample schools were not in line with the prescribed cognitive levels of the CAPS document. The questions of the ANA 2014 test were in line with the prescribed cognitive levels of the CAPS document.

From the analysis of the results of the test/examination of the sample schools and the ANA 2014 test it can be assumed that all learners performed better in the test/examination of their school compared to the ANA 2014 test (cf. 5.6.3). It can be

concluded that the reason for the negative reflection of the ANA 2014 test mark is the fact that most of the learners saw the ANA as unimportant due to the fact that it did not count towards grading (cf. 5.5.3.1).

6.3.4 The ANA and alignment

6.3.4.1 Findings

The fourth objective was to explore if the implementation of the ANA is aligned with the intention of the designers of the ANA 'project'.

The findings obtained from the teachers' interviews and the learners' focus-group interviews, the analyses of various documents (Diagnostic Report of DBE and Teacher D; analysis on the questions in the ANA 2014 test and September 2014 test/examination of the sample schools; results of the ANA 2014 test and September 2014 test/examination of the sample schools) were presented and integrated with the findings of the literature study.

The intension of the designers (DBE) of the ANA 'project' was to establish a world class system of standardized national assessment tests with the aim to improve the performance of learners in Grade 9 to master the minimum Language and Mathematics competencies for Grade 9 (DBE 2013:2-3).

In the study of the literature it was observed that teachers have to be careful to seek similarity between the curriculum objectives, their teaching and the assessment procedures. Furthermore, it is important that what is being taught directly links with what is assessed and *vice versa* (cf. 3.5). The close link between teaching, learning and assessment can also be found in the CAPS document for Mathematics (DBE 2011:154).

Although all teachers interviewed prepared the learners for the ANA by handing out previous years' (2012 and 2013) papers and giving them multiple choice questions (Teacher E), all teachers experienced the pressure of the ANA to complete the work schedule before learners wrote the ANA test in September 2014. Teachers (Teacher A,

C and D) gave extra classes after school hours and summarized chapters (Teacher C) (cf. 5.5.1.1).

The DBE states in the Assessment Guidelines the work that a Grade 9 Mathematics learner will be tested on in the ANA test (DBE 2015a:1-8). Teacher E revealed uncertainty regarding the volume and content of the assessment schedule and was uncertain about the range of work that can be tested in the ANA 2014 test (cf. 5.5.1.1; 5.5.3.2).

Learners should develop the skills and understanding through the process of assessment to continue their progress in the world of further learning (cf. 3.5). Information in the Diagnostic Report of the DBE shows areas where learners are strong and areas where learners experienced challenges (DBE 2014a:4) (cf. 3.7). The majority of teachers involved in the interviews mentioned that their learners' knowledge was of good quality although some teachers (Teacher B, D and E) were concerned that learners did not have appropriate knowledge. Teacher A, B and D highlighted that the 'gap' in Mathematical knowledge comes from the Primary school. In the analysis of the Diagnostic Reports of the DBE and Teacher D it was observed that there were various areas where learners did not perform well, it is especially fractions and geometry that were areas of concern as both of these topics were focused on in the Intermediate Phase (cf. 5.6.1).

The results of the ANA are not part of school-based assessment and are not used for progression and promotion (cf. 3.4.3). Most of the learners interviewed in this study did not see the ANA test as important because the ANA test did not count as a formal test mark on their rapport. The teachers' interview responses revealed that the ANA can be more powerful if it is part of a formal mark on the learner's report (cf. 5.5.3.1).

The purpose of the ANA Diagnostic Report is to improve the quality of teaching and learning and to inform the learners, teachers, principals and management of curriculum implementation, management at national and provincial levels and parents of areas of learners' weaknesses (DBE 2104a:4) (cf. 3.7). Thus, feedback is crucial for learning and helps to reduce the 'gap' between the learners' current level of understanding and/or performance and a desired goal. The purpose of feedback is to enhance learning (cf.

3.6). The teachers' and learners' interview responses revealed that only some of the teachers revised the ANA test with the learners by discussing their mistakes. Some of the teachers gave the ANA scripts back to the learners and some not. Some of the teachers discussed the ANA memorandum and some not (cf. 5.5.2.2). The teachers' interview responses revealed that only Teacher C and E received the Diagnostic Report from the Department (cf. 5.5.2.2).

As mentioned in Chapter 3 of the literature study (cf. 3.8.2) a measure used to evaluate assessment is the level to which a test is aligned with the curriculum learners are using in the classroom. A test is not well aligned if it includes items that require knowledge and skills that are not included in the curriculum. When observing the data conducted during the interviews with the teachers (cf. 5.5.3.2) the majority of teachers mentioned that the ANA 2014 test tested the full range of knowledge of a Grade 9 Mathematics learner (with the exception of Teacher E). Teacher E highlighted that the ANA 2014 test was not fair and some of the questions were on the level of a Grade 10 learner (cf. 5.5.3.2). Teacher B and E revealed that the test/examination papers in their schools are set with the intention to pass the average learner since Grade 9 is the end of the GET phase (cf. 5.5.3.1). In the interviews conducted with the learners, most of the learners mentioned that the ANA 2014 test was difficult and the level of questions was of a higher standard than their school's test/examination papers (cf. 5.5.3.2). The analysis of the test/examination papers revealed that teachers concentrated on questions that required lower level of thinking (Schools B and E) and questions on higher level of thinking were ignored (cf. 5.6.2). In the analysis of the test/examination results it was observed that learners performed better in the test/examination of their schools compared with the ANA 2014 test (cf. 5.6.3).

6.3.4.2 Conclusion

The third objective was to explore if the implementation of the ANA is aligned with the intention of the designers of the ANA 'project'.

For a test to be well aligned it should include questions that require knowledge and skills included in the curriculum (cf. 3.8.2). From the literature review (cf. 3.9) it can be concluded that cognitive levels in test/examination papers play an important role in the

alignment of teaching, learning and assessment. In the analysis of the test/examination papers of the five sample schools (cf. 5.6.2) the absence of all cognitive level questions in the teaching, learning and assessment process also indicated that the development of the learners' abilities to operate on various cognitive levels was neglected. The learners' ability to develop higher order thinking skills was rarely addressed (Except School A and D). It can thus be concluded that most teachers concentrated on lower level questions of thinking and that higher level questions of thinking, which could provide learners with opportunities to practice Mathematics, were ignored. Thus, the cognitive levels of questions in the test/examination of most of the sample schools were not in line with the literature study. It can be concluded that most of the teachers only focused on learners passing test/examination rather than focusing on improving overall learning achievement. Some of the schools did not align their assessment activities with the levels that are prescribed in the CAPS document and tested in the ANA 2014 test. The weaker performance of learners in the ANA 2014 test in comparison with the examination is proof of this as mentioned in the findings above.

Feedback (cf. 3.6) is an important factor in the alignment of teaching, learning and assessment (cf. 3.5). Some of the teachers and learners indicated that the focus of feedback from the teachers was on the handout of the ANA marks and not on communicating learners' weak and strong points (cf. 5.5.2.2). Based on the evidence from the interviews it can be concluded that feedback in its true sense is not executed in the sample schools. Thus, this leads to substandard alignment of teaching, learning and assessment.

The fourth objective was to formulate recommendations and future research possibilities. This objective was achieved through this empirical research.

6.4 RECOMMENDATIONS

The following recommendations are based on the findings and conclusions mentioned above and will focus on the main themes identified in this research, namely on teaching, learning and assessment in a Grade 9 Mathematics classroom.

6.4.1 Recommendations regarding teaching

- The researcher recommends that teachers use all three teaching approaches namely Executive, Facilitative and Liberationist to function well in different school settings with different learners. Thus teachers should focus more on Awareness, Ends and Relationship.
- The intended purpose of the ANA, as envisioned by the DBE was good. However, it may be prudent to let the learners write the ANA test later on in the year or at the start of the next year so that teachers have more time to complete the syllabus.
- The DBE must consider assisting novice teachers with training courses in specifically the geometry part of Mathematics to close the 'gap' of the 'lost generation' that did not have proper schooling in geometry. Therefore, schools need to arrange/facilitate workshops, Continuing Professional Development meetings and encourage teachers to go for in-service training.

- In the light of the uncertainty of Teacher E on the volume and content of the ANA test, it may be sensible that the DBE reviews the load of the curriculum and consider to reduce the volume without losing coherence and progression.

6.4.2 Recommendations regarding learning

- The DBE and school management need to put measures in place to ensure that all teachers engage with the Diagnostic Report so that learners can learn from their mistakes.
- Effective feedback leads to successful learning. It is essential that teachers engage in teaching, learning and assessment and specific feedback to learners. Effective feedback will enable the teachers to determine whether the assessment is in fact assessing what has been taught and learnt.

6.4.3 Recommendations regarding assessment

- When teachers involve learners as partners in the assessment process, for example if the ANA test is part of CASS, it can help learners to build a strong

sense of self-efficacy and develop skills of judgment. Assessment then becomes far more than merely a one-time event attached to the end of a teaching program. Therefore the DBE should consider including the results of the ANA test in a CASS mark.

- The DBE must consider assisting teachers with training courses especially on setting papers on the required cognitive levels of the CAPS document to align teaching, learning and assessment.

6.5 LIMITATIONS OF THIS STUDY

In this study the teachers' and learners' opinions regarding the ANA were investigated. If observations were conducted in the classroom, the researcher could have established more accurately the influence of the ANA on teaching, learning and assessment.

A second limitation of this study is that the researcher analysed only one Diagnostic Report (Teacher D) since the other schools could not present a Diagnostic Report of their school.

Another limitation was that leadership and management teams were not interviewed. Their view of the ANA test and the Diagnostic Report could have been valuable.

It is possible that more factors could have influenced the categories than those considered by the researcher.

6.6 SUGGESTIONS FOR FURTHER RESEARCH

Further research can be conducted in respect of the following areas of interest:

- Greater emphasis is placed on higher order thinking skills in teaching, learning and assessment and although this issue was only touched on in this study, it is suggested that further research be done on the use of educational taxonomies in the alignment of learning and assessment and the development of higher order thinking skills.

- The research was based on a small sample. Although a small sample was used the researcher suspects that similar problems manifest at other schools. A further recommendation is that a similar study be conducted at a wider sample of schools from different provinces.

6.7 CONCLUDING REMARKS

In South Africa the aim of the ANA tests were to improve the quality of assessment practices (DBE 2014b:6-8) and support learning and teaching (DBE 2014a:4) by providing an instrument for teachers to identify learning gaps based on the requirements of the curriculum (DBE 2014b:6-8)

The main question (cf. 1.2) posed by this study was: Does the ANA have an influence on teaching, learning and assessment in a Grade 9 Mathematics classroom? The qualitative study and its data collection techniques were identified as suitable for the purpose of this study and thus applied during the process of data collection, presentation, analysis, conclusions and recommendations.

Findings revealed that teachers experienced pressure from the ANA in their teaching to complete the work schedule before learners wrote the ANA test in September 2014. Conclusions and recommendations of this study suggest that it would have been more practical if the DBE allowed the learners to write the ANA test later on in the year or at the start of the next year.

The driving force of interviewed teachers was to make sure that the learners pass Grade 9 and to spell out exactly what the learners needed to know. It was concluded in the research that teachers interviewed followed an Executive teaching approach.

Findings revealed that learners saw the ANA as insignificant. In the light of the poor performance of learners in the ANA test, learners will only take the ANA test seriously if it contributes towards their final mark. Therefore the DBE should consider making the ANA test part of a CASS mark.

The results of the ANA test are reported in table and narrative form in the Department of Education's Diagnostic Report. This Diagnostic Report of the ANA summarizes the

levels and quality of skills and knowledge that the assessment identified in the system (DBE 2014a:8-9). According to the DBE learners and teachers should be given back their scripts so that they can determine what they did wrong and how they can improve these errors (DBE 2015b:23). Feedback on the ANA 2014 test was questionable. The majority of learners did not receive feedback. Most of the teachers were not aware of a Diagnostic Report and therefore could not assist learners in their weak and strong points. The DBE might deliberate to verify if all schools receive the Diagnostic Report.

It was also noted that there is concern regarding the knowledge of novice teachers who enter the teaching profession. The DBE might consider assisting novice teachers with training courses.

This study also revealed that there is a 'gap' in some of the Grade 9 Mathematics learners' knowledge. The average Grade 9 Mathematics learner does not have sufficient knowledge to manage Grade 9. This is a major problem in a Grade 9 Mathematics classroom since Mathematics instruction builds on learners' existing knowledge.

The CAPS describes four cognitive levels at which assessment have to be conducted. These levels are: Knowledge (25%), Routine Procedures (45%), Complex Procedures (20%) and Problem Solving (10%) (DBE 2011:157). These levels provide a framework for the alignment of teaching, learning and assessment. A test is not properly aligned if it does not include items that require knowledge and skills not included in the curriculum. In this study it surfaced that the questions in the test/examination papers of the sample schools were not in line with the prescribed cognitive levels of the CAPS document.

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Appendix A: Interview Schedule -Teachers

1. Met die koms van die ANA wat geimplementeer is sedert 2011. Vertel vir my hoe ANA jou voorbereiding in die Wiskunde-klas beïnvloed het?

   With the ANA that was implemented since 2011. Tell me how the ANA influenced your preparation of Mathematics in the classroom?

2. Op watter manier het die ANA die waarde weggeneem oor jou opinie wat die beste langtermyn doel is van jou Graad 9 leerders?

   In what ways did the preparation of ANA distract you from judging what the best long term interest is for your learners in Grade 9?

3. Vertel my hoe die ANA jou onderrigstyl verander het?

   Tell me how the ANA changed your teaching style?

4. Wat was jou onderrigstyl voor die koms van die ANA?

   What was your teaching style before the ANA?

5. Wat is jou onderrigstyl nou?

   What is your teaching style now?

6. Op watter manier het die ANA jou assessering in die Wiskunde-klas beinvloed?

   In what ways did the ANA influence your assessment in the Mathematics classroom?

7. Vertel vir my hoe jy jou leerders assesseer.

   Tell me how you assess your learners.

8. In jou opinie, vertel vir my op watter manier die ANA die volle omvang van kennis toets wat ‘n graad 9-leerder behoort te hê.

   In your opinion, tell me in what way the ANA tests the full range of knowledge that a Grade 9 learner should have.

9. Vertel vir my of jy dink die leerders in Graad 9 beskik oor genoegsame kennis van wat hulle behoort te weet in Graad 9.

Tell me if you think learners in Grade 9 have sufficient knowledge to do Grade 9.

10. Wat is jou opinie oor die kennis van onderwysers in Graad 9?

    What is your opinion of the knowledge of a Grade 9 teacher?

11. Oor watter kennis moet ‘n onderwyser beskik om vir graad 9-leerders te onderrig?

    What type of knowledge should a teacher possess to teach Grade 9 learners?

12. Wat is jou opinie oor vakkennis van ‘n graad 9-onderwyser? Verduidelik.

    What is your opinion on the subject knowledge of a Grade 9 teacher? Explain.

13. Is jy tevrede oor jou kennis van jou vak? Verduidelik.

    Are you satisfied with your knowledge on your subject? Explain.

14. In jou opinie, wat is jou einddoel met jou graad 9-Wiskunde leerders?

    In your opinion, what is your goal with your Grade 9 Mathematics learners?

15. Wat wil jy hê moet jou leerders in Graad 9 bereik?

    What do you want your learners to achieve in Grade 9?

16. Met so vol inhoud van die ‘ANA’-toets, vertel vir my hoe jy jou leerders voorberei vir die ‘ANA’-toets.

    With so much content of the ANA test, tell me how you prepare your learners for the ANA test?

17. Verduidelik die druk van die ANA om ‘teaching to the test’ te weerstaan.

    Explain the pressure of the ANA to resist ‘teaching to the test’.

18. Enige kommentaar oor ‘gereedheid van leerders vir ANA’ en ‘voltooiing van die kurrikulum’ in kort tydperk?

    Any comments on ‘readiness of learners for the ANA’ and ‘completing the curriculum’ in a short time?

19. Vertel my hoe jy terugvoer gee aan leerders oor die ‘ANA’-toets.

    Tell me how you give feedback to your learners on the ANA test.

20. Wat is jou opinie oor die waarde van terugvoer van die ‘ANA’-toets?

    What is your opinion of the value of feedback of the ANA test?

21. Enige kommentaar oor die ‘ANA’-toets?

    Any comments on the ANA test?

Appendix B: Interview Schedule - Learners

1. Vertel my hoe die ANA julle gehelp het om Wiskunde beter te verstaan?
   Tell me how the ANA helped you to understand Mathematics better?
2. Hoe het die ANA julle gehelp om Wiskunde beter te leer?
   How did the ANA help you to learn Mathematics better?
3. Hoe het julle Wiskunde-onderwyser julle voorberei vir die 'ANA'-toets?
   How did your teacher prepare you for the ANA test?
4. Hoe het julle Wiskunde-onderwyser terugvoer oor die 'ANA'-toets gegee?
   How did your teacher give you feedback on the ANA test?

Appendix C: Teacher Questionnaire

TEACHER: ……..

Age/Ouderdom	
Years' experience of Grade 9 Mathematics/Jare ondervinding in graad 9 Wiskunde	
Years' experience of ANA/Jare ANA-ervaring	
Qualifications/Kwalifikasies	
Highest qualification in Mathematics/hoogste kwalifikasie in Wiskunde	

Appendix D: Letter of Consent - Principal

The Principal

My name is Steffne Spies, I am an M. Ed. candidate at the University of the Free State, under the supervision of Prof Gawie du Toit. I hereby wish to apply for permission to conduct research at ……..

My study aims to investigate **the nature and extent of the influence of the Annual National Assessment (ANA) tests on the mathematics pedagogy in a Grade 9 Mathematics classroom.** The study will involve the analysis of the September 2014 examination paper of your school of Grade 9 learners, analysis of the ANA paper of September 2014 as well as semi-structured interviews with the teachers and learners of the Grade 9 mathematics class during the third term of 2015. The information obtained will be treated with the strictest confidentiality and will be used solely for the purpose of this research study.

Before commencing with any data collection exercise I will first introduce myself to you as the Principal and come to the school and explain the research and what each of the participant's roles will be.

It is my presumption that the research findings will make a creditable contribution towards identifying different strategies, techniques and methods that will enhance the teaching and learning of Mathematics in grade 9 and that will in tandem in fulfilling the purpose of the ANA as stipulated.

Yours Sincerely

.....
Steffne Spies

If you are willing to give permission to participate in this study, please sign this letter as a declaration of your consent, i.e. that you will participate in this project willingly and that you understand that you may withdraw from the research project at any time. Under no circumstances will the identity of interview participants be made known to any parties/organizations that may be involved in the research process.

Principal's signature…….. Date: ……

Researcher's signature..... Date: ……

Appendix E: Letter of Consent - Teachers

Dear Colleagues

My name is Steffne Spies, I am an M. Ed. candidate at the University of the Free State, under the supervision of Prof Gawie du Toit. I would like to conduct my research project at your school involving your Grade 9 Mathematics learners and teachers. My research topic is **"A pedagogical perspective on the annual national assessment tests in Grade 9 Mathematics".** The research project will involve analysis of the September 2014 examination paper, analysis of the ANA test written in September 2014 as well as semi-structured interviews with teachers and learners at your school. Interviews will take place during the third term of 2015. The information obtained will be treated with the strictest confidentiality and will be used solely for this research purposes only if allowed. Interviews with teachers and learners will be conducted during the third term of 2015.

Before commencing with any data collection exercise I will first come to the school and explain the research and what each of the participants' roles will be.

I hope that the information obtained from this research will benefit your school in identifying different strategies, techniques and methods to enhance learning and teaching of the ANA towards the pedagogy in the Grade 9 Mathematics classroom.

Yours Sincerely

…….
Steffne Spies

If you are willing to participate in this study, please sign this letter as a declaration of your consent, i.e. that you participate in this project willingly and that you understand that you may withdraw from the research project at any time. Under no circumstances will the identity of results or interviews of participants be made known to any parties/organizations that may be involved in the research process.

Participant's signature ……. Date ……

Researcher's signature …….....Date:……

Appendix F: Letter of Consent - Parents

Letter to the parents

My name is Steffne Spies, I am an M. Ed. candidate at the University of the Free State, under the supervision of Prof Gawie du Toit. I hereby apply for permission to conduct research with your child to participate in my research process being undertaken at your child's school. My research topic is **"A pedagogical perspective on the annual national assessment tests in Grade 9 Mathematics"**. This research will entail semi-structured interviews with your child.

I declare that the information obtained from this study will be treated in the strictest confidentiality possible, and it will be used for this research purposes only. Your names, the child's names as well as the school will not be revealed, instead pseudonyms will be used.

The information obtained from this research will be made available to your child's school and can be used by the teacher to help your child to enhance learning in Mathematics.

If you are willing to allow your child to participate in this study, please sign this letter as a declaration of your consent, i.e. that your child participate in this project with your permission and that you understand that he/she may withdraw from this research project at any time.

Parent's signature ……. Date ……

Participant's signature …….. Date ……

Researcher's signature……. Date …….

Yours Sincerely

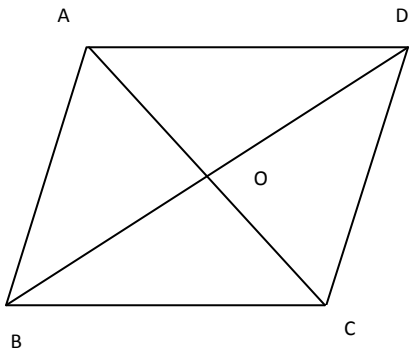
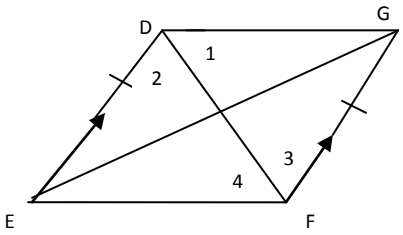
……..
Steffne Spies

Appendix G: Question analysis of the September 2014 test/examination of the sample schools and ANA 2014 test

Table A: School A: Question analysis of September 2014 test/examination

Question no	Question	Knowledge	Routine Procedures	Complex Procedures	Problem Solving	Marks
1.1 1.1.1	Simplify: $2(c^3d^4 + 3d) – 3c^2d^2 \times 2cd^2$		X			3
1.1.2	Simplify: $(2x + 1)(3x + 4)$		X			3
1.1.3	Simplify: $\sqrt{25a^{16} - 9a^{16}}$		X			2
1.1.4	Simplify: $(\sqrt{m} + n)(\sqrt{m} - n)$			X		2
1.2.1	Factorize completely: $x^2 + x$		X			2
1.2.2	Factorize completely: $9 – a^2 b^2$		X			2
1.2.3	Factorize completely: $f^2 + f – 6$		X			2
2.1	Solve for x: $4x - 7 = 3x + 3$		X			2
2.2	Solve for x: $x^2 - 15x + 36 = 0$		X			4
2.3	Solve for x: $\frac{x+1}{20} - \frac{3x-2}{4} = 1$		X			5

<table>
<tr><td>3.</td><td>Jan is three times as old as Piet. In 6 years' time Jan will be twice as old as Piet. Determine their present ages by using an algebraic equation. Let Piet be x years old.</td><td></td><td></td><td></td><td>X</td><td>5</td></tr>
<tr><td>4.1</td><td>If y = 2x + 4, complete the following table:<table><tr><td>x</td><td>-1</td><td>0</td></tr><tr><td>y</td><td></td><td></td></tr></table>Hence plot now above mentioned coordinates in the Cartesian plane. Use Scale: 1 cm = 1 unit.</td><td></td><td>X</td><td></td><td></td><td>4</td></tr>
<tr><td>4.2</td><td>Determine the gradient of the line passing through the following 2 coordinates: (1; 3) and (4; 5).</td><td></td><td>X</td><td></td><td></td><td>3</td></tr>
<tr><td>5.1</td><td>Calculate the circumference of the semi-circle with radius = 9m. Use π on your calculator. Round off your answer to 2 decimals.</td><td></td><td></td><td>X</td><td></td><td>3</td></tr>
</table>

5.2	Calculate the perimeter of a rhombus with diagonals 16 cm and 12 cm.  BD = 16 cm. AC = 12 cm.		X			5
5.3.1	 5.3.1 In quadrilateral DEFG, DE ‖ GF and DE=GF. Prove that Δ DEF ≡ Δ FGD. Hint: Complete the following in your answer book: In ∆DEF and ∆FGD: DE =…….. (Reason…….) $\hat{D}_2$ = …. (Reason…….) ….. = ….. (Reason …….) ∴ ∆DEF ≡ ∆FGD (……..)			X		4

5.3.2	Hence proof that DG ‖ EF.		X			2 Total:53

Table B: School B: Question analysis of September 2014 test/examination

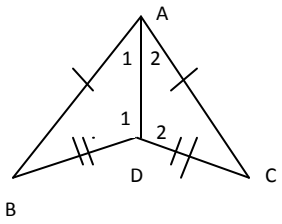
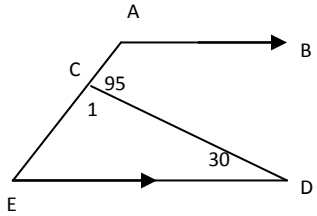
Question no	Question	Knowledge	Routine Procedures	Complex Procedures	Problem Solving	Marks
Section A 1. 1.1 1.2 1.3	Given $\{\frac{2}{5}; \frac{5}{0}; \sqrt{11}\}$ List the following: Rational number Irrational number Undefined number	 X X X				3
2.	$\frac{3}{4}$ (43 + 37) – 28 =	X				1
3.	$\frac{23}{40}$ as %	X				1
4.	4m = _____mm	X				1
5.	204 cm = _____m	X				1
6.	$\frac{3}{4}$ of 528	X				1
7.	$2\frac{1}{2}$ hours = ____minutes	X				1
8.	Convert 275º F to ºC [ºC = $\frac{5}{9}$ (ºF - 32)]	X				1
9.	Write 0,0051 in scientific notation.	X				1
10.1	Simplify:	X				1

	$\frac{1}{2} : \frac{1}{3}$					
10.2	Simplify: 4 : 0,2	X				1
10.3	Simplify: 1 dozen : 3 eggs	X				1
11.1	$a^3 b^4$	X				1
11.2	$(a^3)^4$	X				1
11.3	a^0	X				1
11.4	ab^{-3}	X				1
12 12.1	Solve for x: 2 + x = 10		X			1
12.2	2x = 10		X			1
12.3	$\frac{x}{2}$ = 10		X			1
12.4	(x + 1)(x – 2) = 0		X			2
12.5	3^x = 27		X			1
13.	What type of number is $\sqrt{-16}$?	X				1
14.	Increase 120 in the ratio 4 : 5.	X				1
15.	Decrease 120 with 10 %.	X				1
16.	Give the next term of the following sequence: 3; 5; 8; 12; ___	X				1
17.	$2\frac{1}{2}$ minutes = ___seconds	X				1

18.	$2\frac{3}{4}$ years = ___month	X				1
Section B 1.1	Simplify: $-2x^2 + 2(-x)^2$		X			2
1.2	Simplify : $(3x^{-2}y^{0}z)^3$		X			3
2.1	Consider the following expression: $A= -3x^4 + 2x^3 - 8x^2 - x - 2$ What is the degree of the polynomial?	X				1
2.2	How many terms are there?	X				1
2.3	Write down the constant term?	X				1
2.4	Determine the value of A if x = 1.		X			2
3. 3.1 3.2 3.3	Determine the following products: $(2a + 5b)(2a - 5b)$ $-7a(- a + 1)$ $(a + 1)^2$		 X X X			 2 2 3

5.1	Simplify the following fractions: $\frac{y^2-3y}{y^2-9}$			X		3
5.2	$\frac{x+2}{3} + \frac{x-4}{2}$		X			4
5.3	$\frac{3x^2-6x}{3x}$		X			2
6. 6.1	Solve for x: -x = 12		X			1
6.2	7 + 2x = 9		X			2
6.3	$\frac{3x}{8} = \frac{1}{4}$		X			3
6.4	$x^{-1} = \frac{1}{2}$		X			2
6.5	$x^2 + 3x - 10 = 0$		X			2
7. 7.1 7.2 7.3	Given the pattern: 21; 24; 27; 30…. Determine T_n Determine T_{20} Which term will be equal to 120?			X X X		2 2 2

8.1	Determine the gradient of the line passing through (-3; 5) and (2; 3).		X			2
8.2 8.2.1	Determine the equation of the line y = mx + c with gradient of 4 and y-intercept of - 3.		X			2
8.2.2	parallel to y = 2x + 5 and passing through the origin.			X		2
8.2.3	perpendicular to the line y = 2x + 5 and passes through the co-ordinate (0; 5).			X		2
8.2.4	parallel to the x-axis and passes through the co-ordinate (1;-4).			X		2
8.3	Sketch the following line using the dual-intercept method: 2x + 4y = 16		X			4
8.4	Does the point (2; 3) lie on the line y = 4x – 5?		X			2

8.5	Determine the value of k if (k; 3) is on the line y = -2x – 8.		X			2
9.	 Prove that Δ ABD ≡ Δ ACD with reasons.			X		4
10.	AB ‖ ED. A$\hat{C}$D = 95º and $\hat{D}$ = 30º. Calculate the value of $\hat{E}$ and $\hat{A}$ with reasons. 		X			4
11.1	Give 4 reasons for congruency.	X				4
11.2	Give 2 reasons for similarity.	X				2

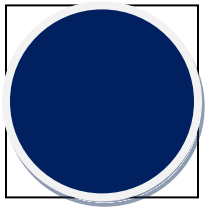
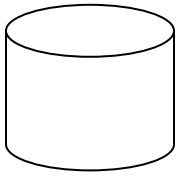
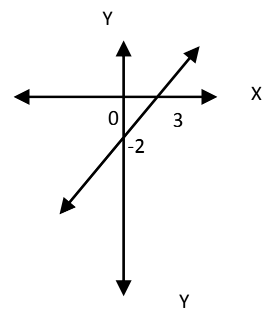
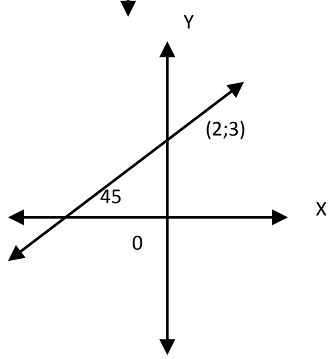
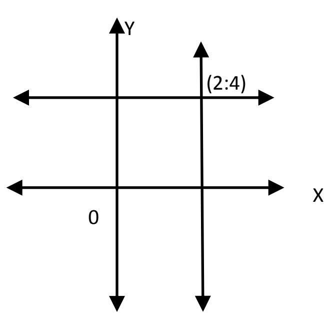
12.1	 In the given figure is a square with sides = 12mm and an included circle. Calculate the area of the white part.			X		4
12.2	Calculate the volume of a cylinder with height = 5 cm and radius = 30 mm (use π = 3,14). 		X			3 Total: 120

Table C: School D: Question analysis of September 2014 test/examination

Question no	Question	Knowledge	Routine Procedures	Complex Procedures	Problem Solving	Marks
1.1	Factorize:					
1.1.1	$6a^2c - 8ac^2$		X			2
1.1.2	$- 20 + x^2 - x$		X			2
1.1.3	$2y(x - y) + (x^2 - y^2)$				X	4
1.2	Solve for x:					
1.2.1	$x^2 + x = 0$		X			3
1.2.2	$27x^2 = 12$		X			5
1.2.3	$3(x - 6) + x^2 = 0$		X			4
1.3.1	Simplify: $\frac{3a}{6a^2 - 9a}$		X			3
1.3.2	$\frac{3x^2 - 5x + 6}{x^2 - 4} \div \frac{x - 3}{4x + 8}$			X		5
2.1	Sketch the following straight lines on a Cartesian plane:					
2.1.1	$y = -2x + 4$		X			3
2.1.2	$- 8 - 4y + 2x = 0$		X			3
2.2	If the straight line $y = 3x + 1$, passes through the coordinate (2; y),		X			2

	determine the value of y.					
2.3	The straight lines $y = mx + 2$ and $y = -4x - 1$ are parallel. Determine the value of m.			X		1
2.4	Determine the equations of the following straight lines in the form $y = mx + c$.					
a)			X			3
b)			X			3
c)			X			2

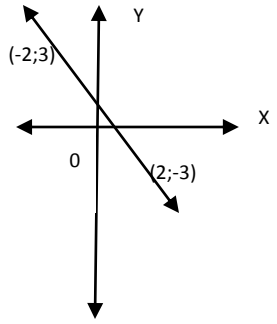
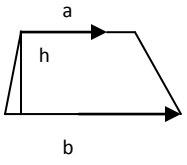
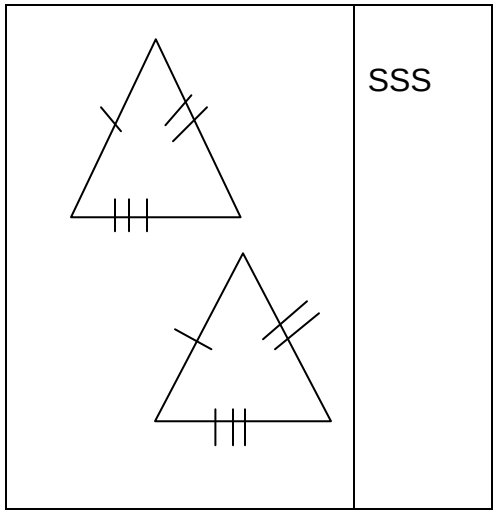
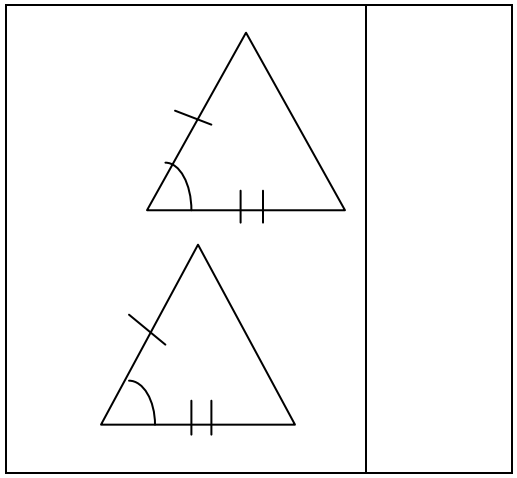
d)			X			5
2.5	Determine the coordinate of A if y = 3x – 8 and 2y = -12x – 10 intersects at A. Give your answer in the form A (x; y).		X			5 Total: 55

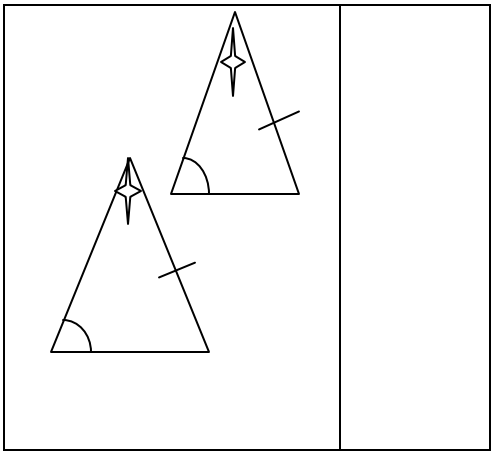
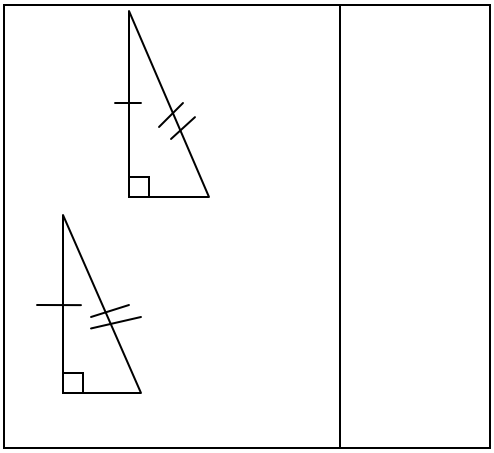
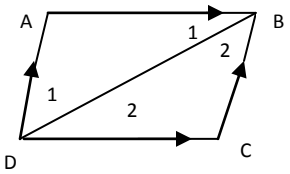
Table D: School E: Question analysis of September 2014 test/examination

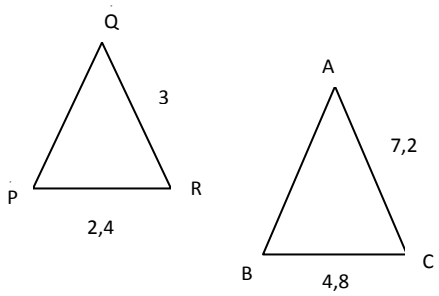
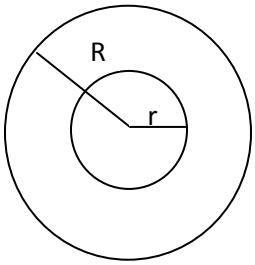
Question no	Question	Knowledge	Routine Procedures	Complex Procedures	Problem Solving	Marks
1.1	Encircle the correct answer. If 5x = 10x, calculate the value of x? A. 2 B. $\frac{1}{2}$ C. 4 D. 0		X			1
1.2	If 4^{x-2} = 1, calculate the value of x. A. $2\frac{1}{4}$ B. 0 C. 2 D. $\frac{9}{4}$		X			1
1.3	"Both opposite sides are parallel" is a characteristic of a… A. Kite B. Trapezium C. Triangle D. Parallelogram	X				1
1.4	Congruency has 4 conditions. Choose the one that DOES NOT fit.					

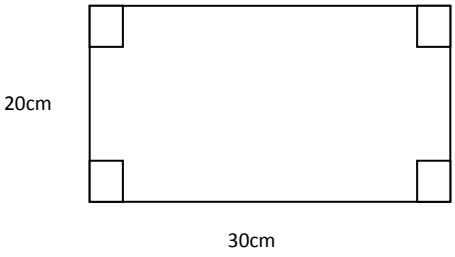
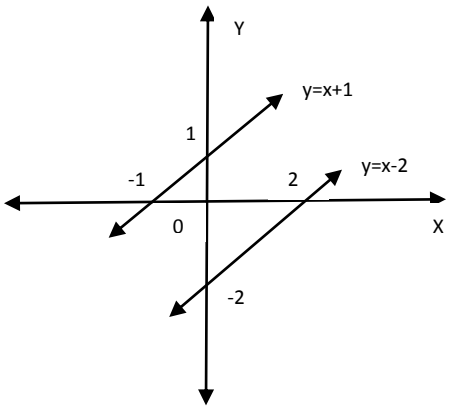
	A. (AAA) B. (SAS) C. (RSS) D. (AAS)	X				1
1.5	The area of a trapezium is calculated by means of the following formulae: A. $[\frac{1}{2}$ (a + b) x h] B. a x b C. 4 x a x h D. $\frac{a}{b}$ x 2 x h 	X				1
1.6	If a figure has an enlarged scale factor of 3, the area enlarges with …. A. 3 B. 6 C. 9 D. 12	X				1
1.7	Simplify: $3a^2b^4c \times 2a^3b^2c^4$ A. $6a^6b^8c^4$ B. $5a^{23}b^{42}c^{14}$ C. $6a^5b^6c^5$ D. $5(abc)^{19}$		X			1
1.8	Factorize: $36(p + q)^2 - 16$ A. [6(p + q) – 4] [6(p + q) + 4] B. 20pq C. $16[2(p + q)^2]$ D. [6(p +q)(p – q)]			X		1

1.9	Factorize: $x^2 - 7x + 10$ A. (x + 2)(x + 5) B. (x – 3) (x + 4) C. (x + 5)(x – 2) D. (x – 5) (x – 2)		X			1
1.10	The theorem of …. is used to determine if a triangle is a right angle triangle? A. Aristotelus B. Fibonacci C. Pythagoras D. Einstein	X				1
2.1	Simplify: 8b – 3(b + a) + 6a		X			2
2.2	Simplify: $\sqrt{2xy^2 X 8x^3y^6}$		X			3
2.3	Factorize: 7x + 14		X			1
2.4	Factorize: 7(x + 1) +5y(x + 1)			X		2
2.5	Factorize: $x^2 + 4x + 3$		X			2
2.6	Solve for x: 2(x – 3) = 8x		X			2
2.7	$2^{x-2} = 16$		X			2
2.8	If $x^2 + 4x + 3 = 0$		X			1

3.1	Complete the following table by fitting the conditions of congruency to the sketches.  SSS					
3.2		X				1

3.3		X				1
3.4		X				1
3.5	The opposite sides and adjacent sides of a rhombus are….	X				1
3.6	ABCD is a rhombus with diagonal BD. Prove the Δ ABD ≡ Δ CBD. 			X		3

4.1	Δ PQR and Δ CAB are similar. Determine the lengths of AB.  			X		2
4.2	and PQ.			X		2
5.1	The following diagram illustrates a donut, viewed from the top. R = radius of big circle (5 cm). r = radius of small circle (2 cm).  The baker would like to work out the area of the part that she wants to put icing on. Help her by determining the area. (Use π = 3, 14). Round off to the nearest integer.			X		3

<table>
<tr>
<td>5.2</td>
<td>She wants to put the donuts in a holder, how many donuts would fit in?
 
</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>6.1</td>
<td> 

Use the above straight lines to complete the following table:
<table><tr><td>x</td><td>-2</td><td>-1</td><td></td><td>1</td><td>2</td></tr><tr><td>y</td><td>-4</td><td></td><td>-2</td><td></td><td></td></tr></table></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
</tr>
</table>

6.2	On the same set of axes sketch the following graph: y = x + 1.		X			3
6.3	What is the relationship between y = x - 2 and y = x + 1, motivate your answer.	X				2
6.4	Sketch the lines y = 2 and x = -3 on the same set of axes.		X			2 Total: 50

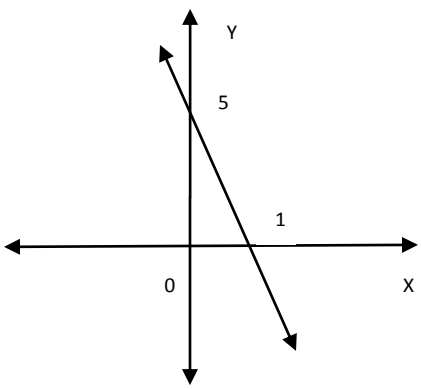
Table E: Question analysis of ANA 2014 test

Question no	Question	Knowledge	Routine Procedures	Complex Procedures	Problem Solving	Marks
1. 1.1	Encircle the correct answer: $\sqrt{16x^{16}}$ A. $8x^8$ B. $8x^4$ C. $4x^4$ D. $4x^8$	X				1
1.2	The LCM of $5a^3$ and $60a^2$ is … A. $60a^5$ B. $30a^3$ C. $60a^3$ D. $300a^6$		X			1
1.3	The product of a number and 6 decreased by 4 is equal to 20. Which of the following equations matches the statement? A. 6x + 4 = 20 B. 6x – 4 = 20 C. 6(x+ 4) = 20 D. 6 – 4x = 20	X				1

1.4	The value of - x^2 - 2(2x - 1) if x = -2, is… A. 6 B. 1 C. -6 D. -1		X			1
1.5	What is the value of $[\frac{2}{3}]^{-3}$? A. $\frac{-6}{9}$ B. $\frac{5}{6}$ C. $\frac{8}{27}$ D. $\frac{27}{8}$	X				1
1.6	$(a + b)^0$ = A. a + b B. 2 C. 1 D. 0	X				1
1.7	What is the value of x if $3^x = \frac{1}{9}$? A. -3 B. 3 C. -2 D. 2		X			1

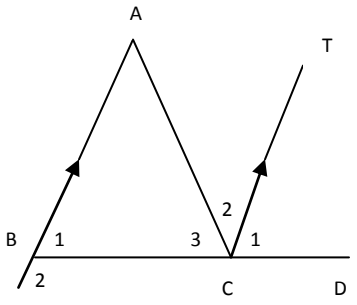
1.8	$\frac{x}{y}$ - 1 = A. $\frac{y-x}{x}$ B. $\frac{y-x}{y}$ C. x – y D. $\frac{x-y}{y}$		X			1
1.9	If 3 is a root of the equation $x^2 + x + t = 0$, the value of t is…. A. 12 B. -12 C. $\frac{1}{12}$ D. $\frac{-1}{12}$				X	1
10.1	If T is a point on the line defined as y = x, then the co-ordinates of T are… A. (5; -5) B. (5; 0) C. (-5; 5) D. (-5; -5)		X			1
2.1	Write 0,000 000 207 mm^2 in scientific notation.	X				1
2.2.1	Calculate, without using a calculator. Show in each case all calculation steps $\sqrt[3]{73-(-3)^2}$		X			2

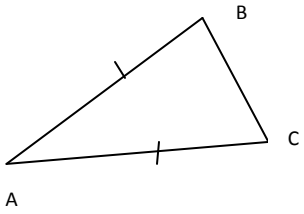
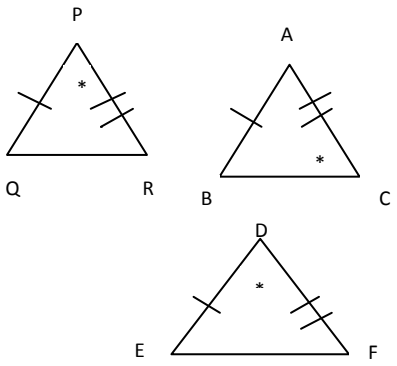
2.2.2	Between which two consecutive integers does $\sqrt{110}$ lie?	X				2
2.2.3	$\frac{3X5^9}{5^7}$		X			2
2.3	Calculate leaving the answer in decimal form. $1{,}03 \times 10^{-2} + 3{,}8 \times 10^{-3}$		X			2
3.1	Simplify each of the following expressions. The denominators in the fractions are not equal to zero. $2(x + 2)^2 - (2x - 1)(x + 2)$		X			4
3.2	$\frac{15x^2y^3 + 9x^2y^3}{8x^2y^3}$		X			2
3.3	$\frac{x^2 - 4x}{x^2 - 2x - 8}$			X		3
3.4	$\frac{x^2}{2} + \frac{2x^2}{3} - \frac{7x^2}{6}$		X			3
3.5	$\frac{6x^2}{7xy} X \frac{3y^3}{2x}$		X			2
4.1	Factorize: $3x^2y - 9xy^2 + 12x^3y^3$		X			2
4.2	$2(x + y) - t(x + y)$			X		2
4.3	$4x^2 - y^2$		X			2
4.4	$x^2 - 11x + 18$		X			2

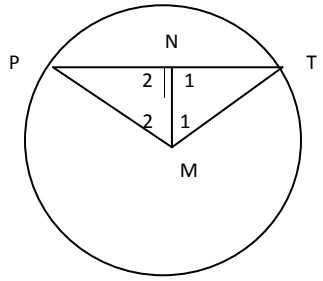
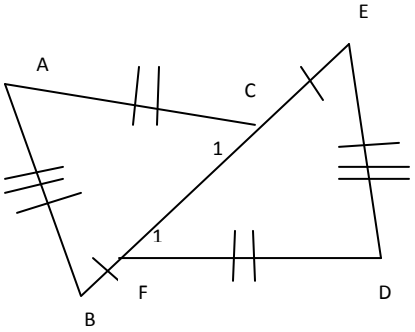
<table>
<tr><td>5.1</td><td>Solve for x:
$(x - 2)^2 + 3x - 2 = (x + 3)^2$</td><td></td><td>X</td><td></td><td></td><td>4</td></tr>
<tr><td>5.2</td><td>$x^2 - 5x - 6 = 0$</td><td></td><td>X</td><td></td><td></td><td>2</td></tr>
<tr><td>5.3</td><td>$\frac{x+2}{3} - \frac{x-3}{4} = 0$</td><td></td><td>X</td><td></td><td></td><td>3</td></tr>
<tr><td>6.1</td><td>Complete the table below:
<table><tr><td>Position in the pattern</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Term</td><td>1</td><td>8</td><td>27</td><td></td><td></td></tr></table></td><td></td><td></td><td>X</td><td></td><td>2</td></tr>
<tr><td>6.2</td><td>Write down the general term T_n of the above number pattern.</td><td></td><td></td><td>X</td><td></td><td>1</td></tr>
<tr><td>6.3</td><td>If $T_n = 512$, determine the value of n.</td><td></td><td></td><td>X</td><td></td><td>2</td></tr>
<tr><td>7.</td><td>Study the graph below:
 
</td><td></td><td>X</td><td></td><td></td><td>3</td></tr>
</table>

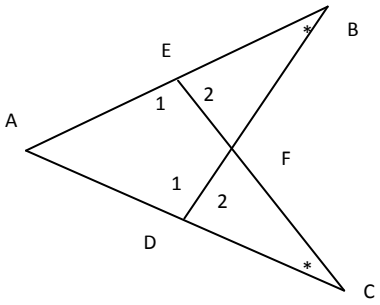
7.1	Use the graph to calculate the gradient of the straight line.					
7.2	Determine the equation of the straight line.		X			2
7.3	Write down the gradient of any other straight line which can be parallel to the given line.	X				1
8.1	Decrease 240kg by 15 %.	X				2
8.2	Nthabi's car uses 1 liter of fuel to travel 12 km. How much fuel will he be needed to travel 420 km?			X		2
8.3	There are 44 boys and girls in Mary's class. The ratio of the number of boys to the number of girls is 5 : 6. How many boys are there in Mary's class?		X			3

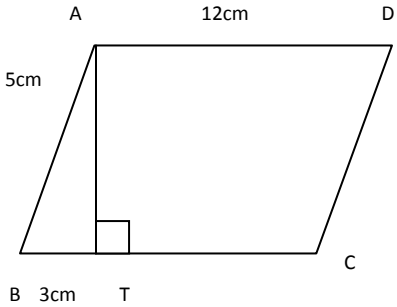
<table>
<tr><td>8.4</td><td>Study the table below:
<table><tr><td>The length of a side of a square in cm</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Area of the square in cm²</td><td>4</td><td>9</td><td>16</td></tr></table>
Is this an example of a direct or indirect proportion? Give a reason for your answer</td><td>X</td><td></td><td></td><td></td><td>2</td></tr>
<tr><td>8.5</td><td>Calculate how long it will take for an investment of R4 000 at 3 % per annum simple interest to earn an interest of R840?</td><td></td><td></td><td>X</td><td></td><td>6</td></tr>
<tr><td>8.6</td><td>Calculate the final amount that I will have in my savings account if I invest R600 for 2 years at a rate of 6 % per annum compounded interest?</td><td></td><td>X</td><td></td><td></td><td>4</td></tr>
<tr><td>9.1</td><td>Complete each of the following statements:</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

9.1.1	$\hat{D}$ and $\hat{F}$ are complementary angles if ….	X				1
9.1.2	The sum of the interior angles of a triangle is equal to ….	X				1
9.1.3	The sum of the exterior angles of any polygon is equal to…	X				1
9.1.4	A trapezium is a quadrilateral with one pair of….sides	X				1
9.1.5	The diagonals of a rectangle are….. in length	X				1
9.2	 In the figure above, AB ‖ TC and $\hat{C}_1$ = 65º and $\hat{C}_2$ = 43º. Calculate the size of $\hat{A}$, $\hat{B}_1$ and $\hat{B}_2$.		X			3

9.3	 In Δ ABC, AB = AC and $\hat{C}$ = x°. Determine the size of $\hat{A}$ in terms of x.			X		3
10.1	 Which triangle is congruent to ΔPQR?	X				2

10.2	 In the given figure, P and T are points on the circle with centre M. N is a point on the chord PT such that MN ⊥ PT. Prove that PN = NT.			X		8
10.3 10.3.1	 In the above diagram AC = DF, AB = DE and BF = CE. Prove that BC = EF.			 X		 2
10.3.2	Prove that $\Delta ABC \equiv \Delta DEF$.			X		5

10.3.3	Why is $\hat{B} = \hat{E}$?	X				1
10.3.4	What is the relationship between AB and ED?	X				2
10.4.1	 In the figure $\hat{B} = \hat{C}$, AD = 9 cm, AE = 7 cm and CE = 21 cm. Prove that Δ ABD is similar to Δ ACE.			X		6
10.4.2	Calculate the length of BD.			X		5

11. 11.1	 In parallelogram ABCD, AB = 5 cm, AD = 12 cm, BT = 3 cm and AT $\perp$ BC.		X			3

	Calculate the length of AT.					
11.2 11.2.1	Calculate : the perimeter of trapezium ADCT.	X				1
11.2.2	the area of trapezium ADCT.		X			3
11.3	The circumference of a circle is 52 cm. Calculate the area of a circle correct to the 2 decimal places.				X	4
11.4	The length of a rectangle is doubled. Write down the value of k, if the area of the enlarged rectangle = k times the area of the original rectangle.	X				1
12. 12.1	Solve for x without using a calculator. Show the calculation steps. X = $(\sqrt{8} + \sqrt{2})^2$				X	3
12.2	$\sqrt{\frac{1}{\sqrt{x}}} = 3$				X	3 Total: 140

Appendix H: Ethics clearance

Faculty of Education
Ethics Office
Room 12
Winkie Direko Building
Faculty of Education University of the Free State
P.O. Box 339
Bloemfontein 9300
South Africa
T: +27(0)51 401 9922
F: +27(0)51 401 2010
www.ufs.ac.za BarclayA@ufs.ac.za

18 August 2014

ETHICAL CLEARANCE APPLICATION:

With reference to your application for ethical clearance with the Faculty of Education, I am pleased to inform you on behalf of the Ethics Board of the faculty that you have been granted ethical clearance for your research with the following stipulations (comments by reviewers):

- It is still somewhat unclear how the learners will be selected – this could be clarified.
- I do not believe the letter to the parents clearly explains what will be expected of the learners. Please modify the letter.
- You only explain how the qualitative data will be analysed. What about the quantitative?

Your ethical clearance number, to be used in all correspondence, is:

UFS-EDU-2014-036

This ethical clearance number is valid for research conducted for three years from issuance. Should you require more time to complete this research, please apply for an extension in writing.

We request that any changes that may take place during the course of your research project be submitted in writing to the ethics office to ensure we are kept up to date with your progress and any ethical implications that may arise.

Thank you for submitting this proposal for ethical clearance and we wish you every success with your research.

Yours sincerely,

Andrew Barclay
Faculty Ethics Officer

Appendix I: Permission letter from the Department of Basic Education

Enquiries: Pepenene MJ
Ref. Research permission
Tel. no: 051 404 9259
Fax no.:086 430 6223
E-mail: pepenene@edu.fs.gov.za

education
Department of Education
FREE STATE PROVINCE

Ms SK Spies
11 Adeane Avenue
BLOEMFONTEIN

Dear Ms Spies

APPROVAL TO CONDUCT RESEARCH IN THE FREE STATE DEPARTMENT OF EDUCATION

1. This letter serves as an acknowledgement of receipt of your request to conduct research in the Free State Department of Education.

   Research Topic: A pedagogical perspective on the Annual National Assessment in Grade 9 Mathematics.

   Approval is herewith granted to conduct research in the following schools:

   Schools involved: Eunice Girls School; Grey College Secondary School; Heatherdale Secondary School; Jim Fouche High School; Sentraal Secondary School and Tsoseletso Secondary School.

   Target Population: Grade 9 teachers - Three (3) classes in six (6) schools and three (3) teachers in each school.

   Period of research: For three months from the date of signature of this letter. Please note that the department does not allow any research to be conducted during the fourth academic quarter of the year.
2. Should you fall behind your schedule by three months to complete your research project in the approved period, you will need to apply for an extension.
3. The approval is subject to the following conditions:
   3.1 The collection of data should not interfere with the normal tuition time or teaching process.
   3.2 A bound copy of the research document should be submitted to the Free State Department of Education, Room 319, 3rd Floor, Old CNA Building, Charlotte Maxeke Street, Bloemfontein.
   3.3 You will be expected, on completion of your research study to make a presentation to the relevant stakeholders in the Department.
   3.4 The attached ethics document must be adhered to in the discourse of your study in our department.
4. Please note that costs relating to all the conditions mentioned above are your own responsibility.

Yours sincerely,

DR. JEM SEKOLANYANE: CFO — **DATE** 07/05/2015

Appendix J: Introduction Letter from Supervisor

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
EDUCATION
OPVOEDKUNDE

8 June 2015

To whom it may concern

I hereby confirm that Steffne Spies is a registered M.Ed. student in the Faculty of Education at the University of the Free State.

The title of her dissertation is: *A pedagogical perspective on the annual national assessment tests in Grade 9 Mathematics.*

Since 2011, the ANA has provided the Department of Basic Education (DBE) with an improved understanding of the impact towards refining Numeracy/Mathematics and Literacy/Language in South African schools. In 2013 the DBE stated that the Grade 9 performance of learners in Mathematics remains below expectations and requires further attention. These poor assessment results are a reflection of the crisis facing Mathematics education in this country.

The over-arching aim of this research is to investigate the nature and extent of the influence of the ANA tests on the Mathematics pedagogy in Grade 9 Mathematics classrooms. It is envisaged that what is learnt from this research might enhance the performance of Mathematics in schools in the Free State province.

I therefore kindly request that Steffne be allowed to conduct this research in schools in the Motheo-district.

Yours truly

Prof GF du Toit
(Supervisor)