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THE IMPACT OF AN INTERACTIVE EDUCATION STRATEGY IN RADIOGRAPHY EDUCATION

by

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DECLARATION

I hereby declare that the work, which is submitted hereby, is the result of my own independent investigation. Where help was sought, it was acknowledged. I further declare that this work is submitted for the first time at this university/faculty towards an M.HPE degree in Health Professions Education and that it has never been submitted to any other university/faculty for the purpose of obtaining a degree.

S.M. Brüssow

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TABLE OF CONTENTS

CHAPTER 1

ORIENTATION TO THE STUDY

CHAPTER 3

RESEARCH DESIGN AND METHODS

CHAPTER 4

RESULTS AND FINDINGS

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ANOVA	Analysis of Variance
ATS	Average Test Scores
APBC	Academic Planning and Budgeting Committee
CPD	Continuous Professional Development
CTM	Committee for Tutorial Matters
DoE	Department of Education
ERIC	Educational Resource Information Centre
LPI	Learning Preference Inventory
MoE	Ministry of Education
NPHE	National Plan for Higher Education
NQF	National Qualifications Framework
OBET	Outcomes-based education and training
OSCE	Objective Structured Clinical Evaluation
SAQA	The South African Qualifications Authority
SAT	Scholastic Aptitude Tests
SAUVCA	South African Universities Vice-Chancellors' Association
SIS	Structured Interactive Sessions
TFS	Technikon Free State.
UFS	University of the Free State.
UOFS	University of the Orange Free State.

SUMMARY

Key terms: Academic achievement; cognitive ability; self-regulation; self-efficacy; motivation; approaches to learning; study skills; learning styles; educational strategies.

Increased access to higher education to address equity is a major objective of *The National Plan for Higher Education* (NPHE) in South Africa. This increased access necessitated more flexible entry requirements to admit previously disadvantaged learners. These learners are, however, inadequately prepared for higher education. Higher education institutions should take this into account in teaching and learning. The rationale for this study was to address the access-success imbalance in higher education mentioned by South Africa's Minister of Education. This research study was thus undertaken to evaluate the impact of an interactive educational strategy in radiography education.

The research took the form of an exploratory, descriptive and quantitative experimental study comprising of a literature review and an experimental investigation. The literature review covered mainly two aspects: The first aspect consisted of factors associated with academic achievement, namely cognitive ability, self-regulation, self-efficacy, motivation, approaches to learning, effective study skills, and learning styles. In the second place, educational strategies were reviewed in the literature, while interactive education was seen as an opportunity to foster the factors associated with effective learning. Effective learning entails encouraging self-regulation, nurturing self-efficacy, raising motivation, promoting a deep approach to learning, teaching and assessing study skills, and accommodating differences in learning styles when teaching. Since the key to effective learning is rooted in the engagement of learners in active and collaborative learning experiences, this productive interaction between

learners and facilitators - which enhances educational events and promotes learning - was therefore explored.

The overall goal of the study was to make a contribution towards optimising the effectiveness of education and training in the radiography programme in the School of Health Technology at the Technikon Free State. The aim was to explore the impact of an interactive education strategy in radiography education on 30 second-year learners enrolled for the modules Radiographic Practice and Clinical Radiographic Practice II (RAD 20 at and KLD 20 at) in 2002, gauged by summative assessment and learner perception.

The empirical study involved a Learning Preference Inventory (LPI) which provided details on learners' learning preferences. The outcome of the LPI directed the design of the Structured Interactive Sessions (SIS), the intervention in which an attempt was made to address the learners' learning preferences. The learners were divided into three study groups, namely a formal lecture group, a self-activities group, and a self-study group. A pre-post test model was used to quantitatively evaluate the improvement in academic performance after the SIS intervention and subsequently a questionnaire survey was carried out to assess learners' perception(s) of the effectiveness of the interactive and self-directed approach to education in radiography.

The results of the three measures, i.e. the LPI, the questionnaire, and the pre-post test model used in the study, shared a prevalent important component, namely the significant role of the facilitator. The LPI results demonstrated dominance in prevalence for a teacher-structured learning environment. The aforementioned fact is confirmed by the distribution of test scores in the pre-test indicating that the groups with no facilitator guidance had lower test marks than the group who received formal lectures. The learners' perception and experiences verified a preference for facilitator-guided activities in class.

The researcher realises the limitations of the study, namely that the study is restricted to performance after a single intervention in a controlled test situation, while learners from one programme were used and the contribution of only interactive education on learning, rather than combinations of factors, was quantitatively explored. It is therefore recommended that both quantitative and qualitative approaches, as well as a larger and more diverse study group, would provide a more widely applicable measurement for academic improvement after an interactive intervention.

The findings of the present study suggest a possible link between interactive educational strategies and academic achievement. The findings also support the literature on academic performance in which motivation through interaction between the facilitator and the learners plays an important role.

OPSOMMING

Sleutelterme: Akademiese prestasie; kognitiewe vermoë; selfregulering; selfwaarde; motivering; benaderinge tot leer; studievaardighede; leerstyle; onderrigstrategieë.

Toenemende toeganklikheid tot hoër onderwys om gelykheid aan te spreek, is een van die hoofdoelwitte van die *National Plan for Higher Education (NPHE)* in Suid-Afrika. Hierdie toenemende toeganklikheid het meer buigsame toelatingsvereistes genoodsaak om 'n groter getal voorheen benadeelde studente toe te laat. Genoemde leerders is egter onvoldoende voorbereid op hoër onderwys. Hoëronderwysinstellings behoort daarmee rekening te hou wanneer onderrig en leer ter sprake kom. Die rasionaal van hierdie studie was om die wanbalans met betrekking tot toelating en akademiese sukses - waarna Suid-Afrika se Minister van Hoër Onderwys ook verwys het - aan te spreek. Die navorsingstudie is dus onderneem om die impak van 'n interaktiewe onderrigstrategie in radiografie-onderrig te evalueer.

Die navorsing het die vorm van 'n ondersoekende, beskrywende en kwantitatiewe eksperimentele studie bestaande uit 'n literatuuroorsig en 'n eksperimentele ondersoek aangeneem. Die literatuuroorsig het hoofsaaklik twee aspekte gedek. Die eerste aspek het uit faktore bestaan wat geassosieer word met akademiese prestasie, naamlik kognitiewe vermoë, selfregulering, selfwaarde, motivering, benaderinge tot leer, effektiewe studievaardighede en leerstyle. In die tweede plek is onderrigstrategieë in die literatuur in oënskou geneem, terwyl interaktiewe onderrig as 'n geleentheid beskou is om die faktore wat met effektiewe leer geassosieer word, te bevorder. Effektiewe leer behels die aanmoediging van selfregulering, die kweek van selfwaarde, verhoogde motivering, die bevordering van 'n diep benadering tot leer, onderrig en die

assessering van studievaardighede, asook die akkommodering van verskille in leerstyle tydens onderrig. Aangesien die sleutel tot effektiewe leer gewortel is in die betrokkenheid van leerders by aktiewe leerondervindinge waartydens hulle moet saamwerk, is hierdie produktiewe interaksie tussen leerders en fasiliteerders - wat onderriggebeure en leer bevorder - dus ondersoek.

Die oorhoofse doel van die studie was om 'n bydrae te lewer tot die optimale effektiwiteit van onderrig en opleiding in die radiografieprogram in die Skool van Gesondheidstegnologie aan die Technikon Vrystaat. Die doel was om die impak van 'n interaktiewe onderrigstrategie in radiografie-onderrig op 30 tweedejaarleerders te ondersoek, gemeet aan eindevaluering en leerderindruk. Genoemde leerders het in 2002 vir die modules Radiografiepraktyk en Kliniese Radiografiepraktyk II (RAD 20 at en KLD 20 at) ingeskryf.

Die empiriese studie het 'n Leerdervoorkeuropname (LVO) [*Learning Preference Inventory* (*LPI*)] behels wat besonderhede oor leerders se leervoorkeure voorsien het. Die uitkoms van die LVO het die ontwerp van die Gestruktureerde Interaktiewe Sessies (GIS) [*Structured Interactive Sessions* (*SIS*)], die ingreep waartydens 'n poging aangewend is om die leerders se leervoorkeure aan te spreek, bepaal. Die leerders is in drie studiegroepe - 'n formele lesingsgroep, 'n selfaktiwiteitsgroep en 'n selfstudiegroep - verdeel. 'n Voor-natoetsmodel is gebruik om die verbetering in akademiese prestasie na die GIS-ingreep kwantitatief te evalueer. Daarna is 'n vraelysondersoek uitgevoer met die oog daarop om die leerders se indruk(ke) aangaande die effektiwiteit van die interaktiewe en selfgerigte benadering tot radiografie-onderrig te evalueer.

Die resultate van die drie - naamlik die LVO, die vraelys, en die voor-natoetsmodel wat tydens die studie gebruik is - het 'n oorwegend belangrike komponent gedeel, naamlik die beduidende rol van die fasiliteerder. Die LVO-resultate het die voorkeur van 'n oorwegend onderwyser-gestruktureerde leeromgewing gedemonstreer. Bogenoemde feit word bevestig deur die verspreiding van toetsresultate van die voortoets wat aandui dat die groepe sonder fasiliteerderleiding laer toetspunte behaal het as die groep wat formele lesings ontvang het. Die leerders se indrukke en ondervindinge staaf 'n voorkeur vir aktiwiteite in die klas wat deur 'n fasiliteerder gelei word.

Die navorser besef die beperkings van die studie, naamlik dat die studie beperk is tot prestasie na 'n enkele ingreep tydens 'n gekontroleerde toetssituasie waartydens leerders van 'n enkele program gebruik is. Verder is die bydrae van slegs interaktiewe onderrig op leer, eerder as 'n kombinasie van faktore, kwantitatief ondersoek. Dit word daarom aanbeveel dat beide kwantitatiewe en kwalitatiewe benaderinge, asook 'n groter en meer uiteenlopende studiegroep, 'n wyer toepaslike meting van akademiese verbetering sal voorsien na 'n interaktiewe ingreep uitgevoer is.

Die bevindinge van die huidige studie dui op 'n moontlike verband tussen interaktiewe onderrigstrategieë en akademiese prestasie. Die bevindinge steun verder die literatuur aangaande akademiese prestasie waarvolgens motivering deur middel van interaksie tussen die fasiliteerder en die leerders 'n belangrike rol speel.

THE IMPACT OF AN INTERACTIVE EDUCATION STRATEGY IN RADIOGRAPHY EDUCATION

CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

In *The National Plan for Higher Education* (NPHE) (RSA MoE 2001) the government is very clear on its expectations. In providing higher education with expected outcomes and targets, for example increased equity in access and success rates, it is also demanded that equity, quality and the social development imperatives of South Africa in the 21st century be met (RSA DoE 1997). To meet these demands, new entry and selection policies were introduced in higher education institutions. The radiography learning programme at the Technikon Free State (TFS) therefore adjusted selection criteria to address equity and the demand for increased enrolments.

Successful admission to the course is based on a Grade 12 certificate or an equivalent qualification. The prerequisite subjects are Mathematics, Physical Science and Biology or Physiology with at least 50% on standard grade or 40% on higher grade. Prospective learners should pass both Afrikaans and English (TFS 2001:86). A candidate for a diploma previously had to score at least 27 or more points on the Technikon Scoring Scale (Swedish scale) in the Grade 12 examination in July to be invited to undergo selection tests. To adhere to the demand of increased enrolment the Technikon Scoring Scale requirements were lowered from 27 to 25 during the post transformation period. This was formalised in 2001 but had been applied informally earlier. Candidates must successfully complete the selection process. The following measures were included in the selection tests and used for potential determination: The shortened Scholastic Aptitude Test (SAT) as a power test (Claassen, De Beer, Hugo & Meyer 1991:8), a test constructed to measure academic intelligence or scholastic aptitude and the English Proficiency Test which measures a candidate's understanding of and proficiency in English.

The application of these new policies led to the rapid expansion of a new population of learners in radiography education. The learners typically have different levels of academic ability and diverse cultural backgrounds. These diverse learners generally did not comply with the academic success rates previously achieved. The average percentage failures increased from 38.5% up to 1995 to 61.8% after 1995 (see Table 1.1).

Table 1.1: Enrolments versus learners who fail an academic year

Year	Enrolments	Failures	Failure rate %	
1990	23	8	34.8	**Up to 1995**
1991	22	6	27.3	Average
1992	26	11	42.3	percentage
1993	29	12	41.4	failure rate
1994	25	8	32.0	39.5%
1995	27	16	59.3	
1996	27	19	70.4	**After 1995**
1997	28	20	71.4	
1998	27	17	63.0	Average
1999	21	12	57.1	percentage
2000	24	11	45.8	failure rate
2001	43	27	62.8	61.8%

This phenomenon was also experienced on national level. Education Minister Kader Asmal reported during a media briefing at Parliament in February 2003 that 85% of learners who enrolled at tertiary institutions in South Africa did not graduate; the throughput rate of 15% was too low; and his department wanted to increase this rate by at least 5% (Stewart 2003). A study done in the Medical School at the University of Natal ascribed the failure of learners from disadvantaged educational and socio-economic backgrounds mainly to an inability to "bridge the gap" between their two worlds, that of everyday life and that of higher education (Bezuidenhout in McLean 2001:408).

Traditionally the education approach in radiography was concomitant with the remarks made by Turchin, Lehmann and Flexner (2000:271). They observe that, since ancient times, the Socratic method of teaching with its emphasis on asking learners questions and providing feedback on the answers was popular among educators. Minton (1998:399) states that in radiography education this culture of teaching rather than learning prevails with teaching following a largely pedagogic style. This is an approach frequently encountered in radiography instruction, especially in the day-to-day clinical education of learners during experiential learning. Minton (1998:399) argues that these strategies were effective in an era when fewer learners were selected; where the learners were of a more homogeneous nature; and small classes ensured adequate contact between learners and their lecturers. Morrison (2001:7) supports the notion in stating that in the days when university classes contained highly selected learners, the traditional lecture appeared to be successful, but at present, with a more diversified learner population, many learners seem unable to cope.

In view of the diverse cultural and educational backgrounds of the radiography learners at the TFS the lack of academic success in the radiography programme in this study therefore indicates that the traditional methods of teaching, that is formal lectures, are no longer effective. The diverse academic capabilities of radiography learners have been ascribed to the fact that many are English second-language learners and received a less than adequate secondary education that did not fully prepare them for higher education. The use of educational strategies that will improve learners' learning and hence academic success has become crucial. The question to answer is: How can facilitators assist learners to learn more effectively? Research studies provide the answer: Learners learn more effectively when they are actively engaged in the learning process (Harden & Crosby s.a.; Ames & Archer 1988; Wentzel 1991; Davis & Harden 1999; Baxter & Gray 2001; Chase & Geldenhuys 2001; Gettinger & Seibert 2002).

Similarly, Barr and Tagg (1995:22) suggest that an instruction paradigm does not teach learners to learn efficiently and effectively. They propose that facilitators should design a learning environment that will provide better results. They state that academic institutions should not exist to provide instruction, but should exist to produce learning; thus forcing a shift from teacher to learner, an advance both needed and wanted in radiography education so as to enhance the learning process and improve pass rates.

The National Qualifications Framework (NQF) (2000:8) confirmed the need. It proposed that it should be the intention of any learning programme to realise the importance of reflecting on and exploring a variety of strategies to enable learning that is more effective. Strategies that encourage effective learning; that are learner-centred and active learning; the causes for underachievement; and the resolution thereof were looked into in the literature and used as foundation for the present investigation.

An overview of the literature on academic achievement; the factors associated with academic achievement; cognitive ability and self-efficacy;

self-regulated learning; motivation; approaches to learning; study skills and learning styles follow. The value of active, learner-centred and interactive learning in academic achievement will be addressed in the next section to provide a background for the investigation at hand.

1.2 ACADEMIC ACHIEVEMENT

Academic achievement, which is the level of success attained in an academic area (Dark 1998), has been the focus of extensive educational research (Krouse & Krouse 1981:151; Zimmerman 1990:3; Carr, Borkowski & Maxwell 1991; Pimparyon, Poonchai, Roff & Pemba 2000:359; Ferguson, James & Madeley 2002:952; Kumar 2003:25). Learners' characteristics, abilities, conception of learning, and orientation to learning are concomitant determinants of academic achievement. Linnenbrink and Pintrich (2002:313) affirm that academic enablers (non-academic skills that contribute to academic success) - which include the entirety of intrinsic motivation, goal orientations, social skills and self-efficacy - are key elements to consider when reviewing academic achievement.

1.3 FACTORS ASSOCIATED WITH ACADEMIC ACHIEVEMENT

Factors in the literature which are associated with academic achievement (Thompson & Geren 2002:398) are, among others, the following:

- Cognitive ability (Gully, Payne, Kiechel & Whiteman 2002:147; Linnenbrink & Pintrich 2002:314).
- Self-regulation (Zimmerman & Martinez-Pons 1988:284; Zimmerman 1990; Leung, Lam & Hedley 2001:1072; Kitsantas 2002:109; Gettinger & Seibert 2002:350; Ruban, McCoach,

McGuire & Reis 2003:270; Sanz de Acedo Lizarraga, Ugarte, Iriarte, & Sanz de Acedo Baquedano 2003:65).

- Self-efficacy (Zimmerman 1998:81; Davis & Harden 1999:130; Pimparyon *et al.* 2000:363; Sobral 2001:508; Gully *et al.* 2002:147; Kitsantas 2002:103; Linnenbrink & Pintrich 2002:315).
- Motivation (Ames & Archer 1988:261; Cleave-Hogg & Rothman 1991:456-474; Zimmerman 1998:73; Davis & Harden 1999:133; Nasmith & Steinert 2001:48; Linnenbrink & Pintrich 2002:314; Kumar 2003:24).
- Approaches to learning (Entwistle in Pimparyon *et al.* 2000:359; McLean 2001:401; Diseth 2002:221; Gordon & Debus 2002:484).
- Effective study skills (Zimmerman 1998:73; Gettinger & Seibert 2002:350; Thompson & Geren 2002:398).
- Learning styles (Martin, Stark & Jolly 2000:531; Ferguson *et al.* 2002:962; Boyle, Duffy & Dunleavy 2003:268; Wigen, Holen & Ellingsen 2003:32).

The relevance of the above-mentioned factors in the current study is briefly touched on in the ensuing paragraphs. Since cognitive ability with its complexity is difficult to alter, especially when contact between facilitators and learners is limited. Hence only factors which could possibly enhance academic achievement, and which the facilitator has an influence over, were looked into. Interaction between the facilitator and the learner during contact time was seen as an opportunity to foster these factors which are to encourage self-regulation, nurture self-efficacy, raise motivation, promote a deep approach to learning, teach study skills and accommodate differences in learning styles.

1.3.1 Cognitive ability

Cognitive ability is considered as a factor associated with academic achievement and is seen by Brody and Furnham in Diseth (2002:219) as a major predictor of academic competence. Gully *et al.* (2002:147) add that "cognitive ability" refers to the ability to integrate, process, and apply information. Since educators believe that learners perform at a lower level of competency than what their capabilities are, they attempt to enhance learners' cognitive ability even though it is so complex (Sanz de Acedo Lizarraga *et al.* 2003:59). The authors also suggest that any attempt to enhance cognitive ability should include motivation through learners' active participation in the learning process and add that cognitive ability and self-regulation are interrelated.

1.3.2 Self-regulation

In the early 1990s educational researchers identified a process in which learners mastered their own acquisition of knowledge and called it self-regulated learning (Zimmerman 1990:3). Zimmerman (1998:73) describes self-regulation as self-generated feelings and behaviour to reach academic goals. The value of self-regulation in the present study is put forward by Kitsantas (2002:109) who states that self-regulation and self-efficacy beliefs positively affect academic outcomes and adds that self-regulated learners are also self-motivated.

1.3.3 Self-efficacy

The findings of Gully *et al.* (2002:147) and the views of Davis and Harden (1999:130) indicate that cognitive ability predicts self-efficacy (one's perceived capability to perform a task). The results of Gully *et al.* (2002:147) testify that ability is positively related to self-efficacy, a fact also noted by Linnenbrink and Pintrich (2002:313) and Pimparyon *et al.* (2000:359-365). The changes in the selection and access policies in radiography education caused a wide variation in learners' cognitive ability and therefore also their self-efficacy.

Self-efficacy is learners' beliefs about their performance capabilities in a specific context, task or domain (Linnenbrink & Pintrich 2002:315). Davis and Harden (1999:130) indicate that self-efficacy controls task performance, determination and effort. It also influences thought patterns, motivation and performance. A learner's own academic self-efficacy is formed by that of the facilitator (Gordon & Debus 2002:484). Self-efficacy as a factor associated with academic achievement was therefore seen as a characteristic that can be improved in the radiography learning programme.

1.3.4 Motivation

According to Davis and Harden (1999:130), taking responsibility for one's own learning, rather than having the subject and method of learning dictated, enriches the learning experience while presenting an intrinsic motivation to learn. The statement that increased motivation enhances effective learning (Ames & Archer 1988:261; Davis & Harden 1999:133; Nasmith & Steinert 2001:48; Kumar 2003:24), shows that if the learners in the radiography programme are motivated, academic performance can be improved. To find an educational strategy that motivates learners not only became essential, but also a challenge.

1.3.5 Approaches to learning

Pimparyon *et al.* (2000:362) see an association between approaches to learning and the educational environment as factors associated with academic achievement. The authors state that it is important that educators create an optimal educational environment that promotes a deep approach to learning which is positively correlated with academic achievement in contrast with a surface approach which puts learners at risk of failing. The authors urge educators to apply interventions to address underachievement, a statement that supports the intent of the current investigation.

1.3.6 Study skills

Gettinger and Seibert (2002:350) indicate that learners with low academic competence demonstrate ineffective study skills in that they play a passive role in the learning process and rely on facilitators to control their learning. Learner passivity should therefore be avoided and lecturer-learner interaction should support the learner in obtaining effective study skills.

1.3.7 Learning styles

According to Ferguson *et al.* (2002:953) and Steele, Johnson, Jodi, Thomas, Lacy and Duffy (2002:225), learning styles are also associated with academic performance. The results presented by these authors suggest that work on learning styles is expected to be productive if the different learning styles of learners are accommodated in the education process. However, using only learners' learning approach as a predictor of academic achievement is not adequate in forecasting learners' performance, as indicated in the previous paragraphs.

1.4 EDUCATIONAL STRATEGIES

The learning environment, which includes all the aforementioned determinants of academic achievement, seems to be more useful in predicting effective learning approaches. The implications include the need for designing a supportive environment, as well as creating and implementing interventions in the form of educational strategies to remedy unsatisfactory elements of the environment to reach academic success (Pimparyon *et al.* 2000:365).

It is clear from the previous paragraphs that academic achievement determined by the process and product of learning is complex. The use of effective educational strategies therefore is of the utmost importance to ensure an optimal learning milieu. Albert Einstein's (1879-1955) philosophy: "I never teach my pupils. I only attempt to provide the conditions under which they can learn" validates the importance of exploring educational strategies that will indeed create these conditions.

Since educational literature has for some time recognised the importance of learner-centred teaching and learning where learners are active participants in the learning process (Baxter & Gray 2001:396), the implementation of an active and learner-centred approach to education seemed meaningful.

1.4.1 Learner-centred learning

Research from diverse perspectives has shown that learning is enhanced when classroom environments encourage learner involvement, personal responsibility, and when learners themselves are committed to understanding and learning (Ames & Archer 1988:261). Bitzer and Pretorius (1996:1) confirm the success of this learner-centred approach and note that resource-based learning is an educational approach by which learning content is made accessible to learners in ways other than the traditional lecture. According to Bitzer and Pretorius (1996:1), the accent is shifted from the lecturer as the conveyer of knowledge to the lecturer as the facilitator of knowledge. Similarly, the learner as the "active discoverer" replaces the significance of the learner as the "recipient" of knowledge.

1.4.2 Active learning

Various researchers regard active learner participation in the learning process as an affirmative criterion as well as an important factor for the enhancement of learning and thus academic achievement (Harden & Crosby, s.a.; Ames & Archer 1988; Wentzel 1991; Barr & Tagg 1995; Baxter & Gray 2001; Chase & Geldenhuys 2001; Morrison 2001; Gettinger & Seibert 2002; Kumar 2003). Boyle *et al.* (2003:267) state that effective learning is characterised by an active and self-regulated approach to learning. Davis and Harden (1999:133) verify this statement that, if the learner is actively engaged in the learning process, the understanding and retention of information are improved. Learner-centred learning and learners' active involvement in the learning process is seen by the NQF

(2000) as a way to achieve academic success. Active learner involvement encourages independent learning and is the foundation of an outcomes-based education and training (OBET) curriculum. The aim of the OBET approach is to improve the accountability of learners and to lay a foundation for the development of a learning society (Coetzee-Van Rooy & Serfontein 2001:10). These views therefore suggest that, if the learners in the radiography programme are actively involved in the learning process and take responsibility for their own learning, academic success could be within reach.

1.4.3 Interactive learning

Interactive learning, an educational strategy that increases learner participation, entails an increased interchange among teachers, learners and the lecture content. The use of interactive lectures can encourage active learning; increase attention and motivation; give feedback to the teacher and the learner; and increase satisfaction for both (Steinert & Snell 1999:37). Chase and Geldenhuys (2001:1072) support this viewpoint and identify the advantages of interactive contact sessions observed during their survey of a class with a wide range of academic abilities. Since a learner guide is an instrument intended to facilitate teacher-learner interaction (Harden, Laidlaw & Hesketh 1999:249), the use thereof in this study seemed essential.

1.4.4 Learning guides

The shift from a teacher-centred to a learner-centred approach to education requires that learners become more accountable for their own learning (TFS 2003:1). Since the learners in the radiography programme needed direction and support with this approach, the learner guide had an important function to fulfil (Harden *et al.* 1999:249).

1.4.5 Key solution

Owing to the work of educational establishments namely the TFS, the UFS and the professional body, the Professional Board for Radiographers, educators in radiography at the TFS have become increasingly familiar with the concept of OBET, which is based on an active and learner-centred approach. In search of a means to improve academic success, the educators applied the methods advocated by the OBET approach. However this active and learner-centred approach alone did not lead to an improvement in pass rates. The ongoing lack of academic success was ascribed to the fact that learners with academically deprived backgrounds require substantial support from facilitators and do not take responsibility for their own learning (Holsgrove, Lanphear & Ledingham 1999:99). The use of only an active or learner-centred approach in radiography seemed inadequate to address the educational needs of the present diverse learner population.

According to the aforementioned literature, the academic failure encountered in radiography has therefore the following key solution: To address the inability of the learners to learn independently, education should be based on an interactive educational strategy, which implies that the facilitator directs the learning process and guides learners to become independent learners. The need to explore the impact of an interactive education strategy in radiography education has become pertinent. The problem statement follows and confirms the need for the proposed investigation.

1.5 STATEMENT OF THE PROBLEM

According to the South African Qualifications Authority (SAQA), a learner-centred approach presents exciting opportunities for the development and implementation of new educational tools which allow a shift from lecturer to learner (RSA 1995). Although the new demands have forced the radiography educators at the TFS to change the educational approach, the learners failed to commit themselves to this proposed independent learning, as revealed in the poor pass rates. A similar stumbling-block was encountered by Holsgrove *et al.* (1999:99). Through their experience with learner-centred learning in learners from diverse backgrounds, they observed that a simple shift from teacher to learner was not possible.

Learners with academically deprived backgrounds require much more support and encouragement to take advantage of active learning and teacher support (Holsgrove *et al.* 1999:99). These authors conclude that learning guides should be considered as an important feature in the process of instilling an interactive mindset among learners and guiding them towards independent learning.

Since the proposed shift from lecturer to learner was not accomplished in the radiography programme of the TFS, it was deemed necessary to circumvent the resistance or lack in ability of learners to take responsibility for their own learning. The literature referred to in the preceding paragraphs shows that, in order to improve learning, an interactive education strategy, based on a learner guide that acknowledges learning styles, could be of value to enhance study capabilities and thus academic performance in a diverse learner population.

No study has investigated the impact of an interactive education strategy in radiography education and compared interactive learning with traditional methods of teaching (formal lectures for example). In other disciplines in which these comparisons have been made, interactive learning has proved to yield better academic outcomes compared to the implementation of traditional methods. Against the background of a lack of research evidence a need exists to validate the effectiveness of an interactive education strategy based on a learner guide in the radiography programme which accommodates learning style preferences as put forward in the introduction. Given the above-mentioned problem, the investigation sought to answer the following questions:

- Does the implementation of an interactive educational strategy, which accommodates learning style preferences, based on a learner guide, influence academic performance in a diverse learner group in radiography education?
- Do radiography learners with diverse academic abilities and cultural backgrounds prefer interactive teaching approaches in order to improve their academic performance?

1.6 GOAL, AIM AND OBJECTIVES OF THE STUDY

1.6.1 Goal

The overall goal of the study is to make a contribution towards optimising the effectiveness of education and training in the radiography programme in the School of Health Technology at the Technikon Free State.

1.6.2 Aim

To achieve the goal, the impact of an interactive education strategy in radiography education, gauged by summative assessment and learner perception, was explored.

1.6.3 Objectives

To achieve the aim and the goal of the investigation in addressing the problem statement, the following objectives were pursued:

- An extensive literature survey on academic achievement was conducted. The determinants of academic achievement - that is factors facilitating or constraining learners' learning, educational strategies and innovations in the field of interactive instruction in higher education - were looked into and were used as background for the investigation.

- Learners' Scholastic Aptitude Tests (SAT) were collected to serve as indicators of cognitive ability.
- A descriptive inventory outlined by Rezler (1974:101) was completed to identify the learning trends and preferences of learners.
- The information thus collected was used to develop an educational strategy aimed at enabling learners from diverse backgrounds to improve their academic performance.
- To determine the impact of an interactive education strategy on learner performance, as compared with the more traditional teaching methods, an experimental method (pre- and post-intervention test scores) was implemented to quantify improvement in learner performance. Learners were divided into 3 groups, namely a formal lecture group, a self-activities group and a self-study group whereafter all learners had the interactive education strategy.
- A research instrument (questionnaire) was designed to determine the participants' perception(s) of the effectiveness of the interactive and self-directed approach to education in radiography.

1.7 SCOPE OF THE STUDY

The investigation was conducted in the study field of Health Professions Education at a higher education level. The area of concern was the evaluation of radiography education, with specific reference to academic performance. Wilkes and Bligh (1999:1270) classify four general approaches to educational evaluation, namely learner-, programme-, institution-, and stakeholder-oriented approaches. For the purpose of the present investigation only a single learner-oriented educational evaluation approach was adopted.

Two themes in the diagnostic radiography programme for second-year learners in 2002 in the School of Health Technology at the TFS were used as basis for the empirical study. The lecturer responsible for academic matters concerning second-year learners conducted the investigation.

1.8 SIGNIFICANCE AND VALUE OF THE STUDY

There is a need to question methods of teaching and learning (Pedley & Arber 1997:11). In support of this view, Wilkes and Bligh (1999:1269) report that educational evaluation is the systematic appraisal of the quality of teaching and learning. It has a formative role, identifying areas where teaching can be improved; or a summative role, judging the effectiveness of teaching. In addition, the feedback of learners is important in evaluating education strategies. The authors recommend that evaluation should form an early part of the educational change process. Therefore, exploring the impact of an interactive education strategy in radiography, served to clarify the potential educational approach in order to improve academic performance in diverse learners.

Features of the investigation were to articulate a theoretical perspective on the contribution of an education strategy to academic achievement in radiography education, as well as to identify strategies which are effective in helping learners to succeed academically. The value of the study is in the implementation of results in the existing radiography education programme to optimise teaching and learning, as well as to ensure compliance with higher education standards and demands. Diversity in the learner population could be accommodated and guidance to self-efficacy undertaken.

Since OBET encourages various learner-centred teaching and learning strategies which lead to self-directed learning and, ultimatly, independent learning, the study investigated the comparison between formal lectures, self-activities and self-study.

1.9 METHODS OF INVESTIGATION

An experimental educational intervention was used for the investigation. The following steps explain the process: A Learning Preference Inventory (LPI) was conducted (Rezler 1974:101) to indicate the approach to the planned educational strategy, the intervention. A learning guide was used during structured interactive sessions to increase learner-centred learning. The efficacy of this interactive and self-directed education strategy was determined, based on a quantitative investigation and was compared with formal lectures, independent self-study and self-activities.

1.9.1 Study design

The study design, a quantitative experimental study with descriptive components, was fourfold (see Figure 1.1):

1. A Learning Preference Inventory (LPI) was conducted.
2. Before the interactive educational intervention, learners were divided into three groups, namely a formal lecture, a self-activities and a self-study group. Whereafter all learners received the interactive educational strategy.
3. An experimental method was used in which the aim was to quantify improvement in learner performance based on a standard, namely a one-correct-answer test model, before and after an interactive educational intervention in order to determine the impact of the interactive educational strategy on learner performance as compared to the more traditional teaching methods.
4. A questionnaire was designed to evaluate the learners' perception of the effectiveness of structured interactive sessions and the learner-directed approach to education in radiography.

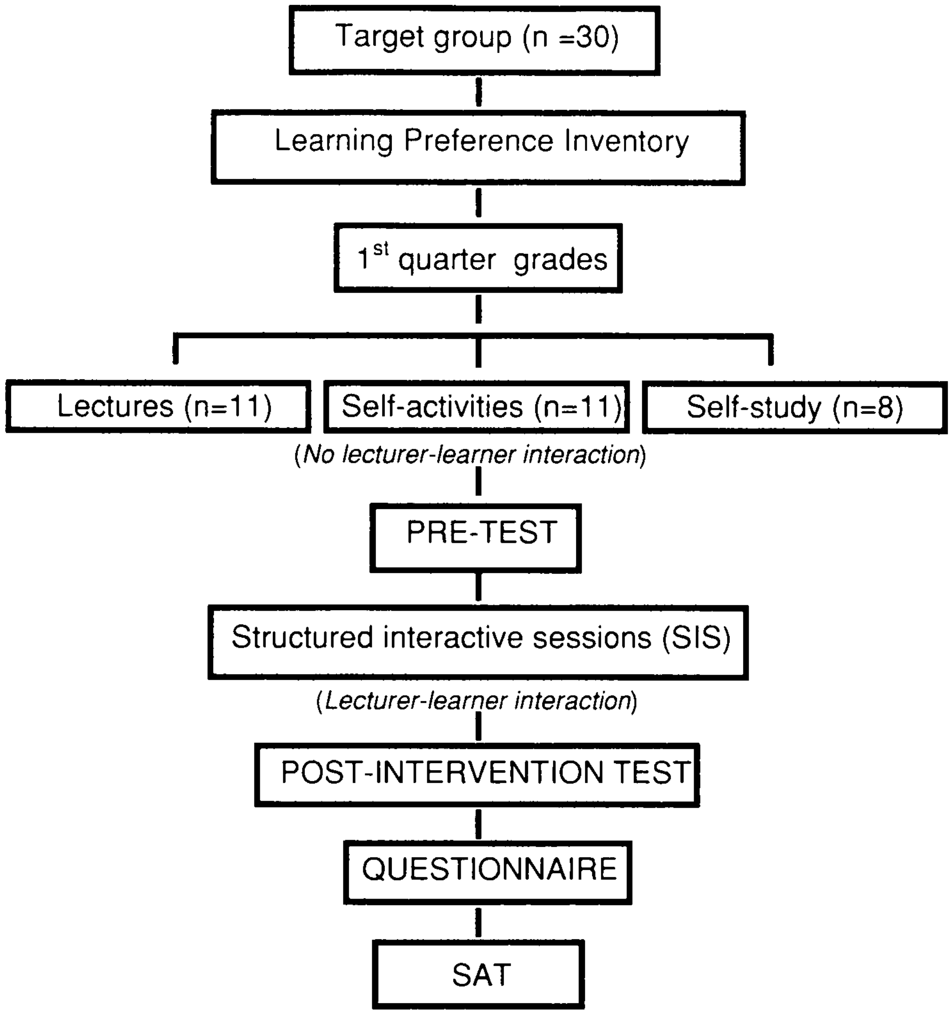

Figure 1.1: Study design

1.9.2 Target group

The target group comprised 30 second-year learners enrolled in the learning unit Radiographic Practice II (RAD20 AT) in the programme Diagnostic Radiography in the School of Health Technology at the TFS in 2002. Participants were assigned to one of three learning conditions:

I. Formal lectures
II. Self-activities
III. Self-study

The learning material was developed in such a way as to ensure that all participants could achieve identical outcomes. This was followed up with the educational strategy, structured interactive, self-reflective, and learning guide-oriented contact sessions (the educational intervention), which included all the participants. The division of groups was based on previous academic records, with each group consisting of an equal number of high-level, average, and low-level academic performers. Individual participants were considered as their own control.

1.9.3 Measurement

A pre- and a post-intervention test to evaluate learners' knowledge of radiographic anatomy and radiographic procedures were used. The tests consisted of a collection of questions from a published review guide used in radiography programmes at tertiary academic institutions (Bontrager 1993:217). These questions were composed to have a single best answer. Improvement in subject performance from pre- to post-intervention sessions served as the primary endpoint, while the learners' subjective evaluation of their experience served as a secondary endpoint. Methodological and measurement errors were avoided (see a description in Chapter 3, paragraph 3.5).

1.9.4 Pilot study

The questionnaire was completed by 20 third-year learners in the same programme. Ambiguous questions were rectified and difficult terminology changed to more understandable terms. During the main study participants were allowed to ask for clarification of questions they did not understand.

1.9.5 Analysis

The Department of Biostatistics at the University of the Free State (UFS) was consulted for recommendations regarding the management of data and the processing of results. All statistical analyses were performed by the researcher. Appropriate summary statistics were calculated and comparisons made between and within groups.

1.10 DEFINITION OF TERMINOLOGY

Terms referred to in this study are explained and extended on in the following paragraphs:

Academic ability: Academic or cognitive ability refers to the ability to integrate, process and apply information (Gully *et al.* 2002:147).

Academic achievement: Academic achievement is the success in bringing an effort to the desired end; the degree or level of success attained in an academic area (Dark 1998).

Academic competence: Academic competence is associated with the knowledge and use of effective study skills (Gettinger & Seibert 2002:350). It is defined as a multidimensional concept made up of learners' skills, attitudes, and behaviour (DiPerna & Elliott 2002:293).

Academic enablers: Academic enablers are attitudes and behaviours that allow learners to take part in and ultimately benefit from academic instruction in the classroom (DiPerna & Elliott 2002:293).

Academic self-regulation: Academic self-regulation refers to the progression in which learners initiate and maintain cognition, behaviours and affects that are focused on reaching academic goals (Zimmerman 1998:73).

Active learning: Active learning is a process in which learners become engaged in making meaning of information when facilitators include opportunities in a class where the learners are engaged in an activity in which they use new knowledge or skills (Huang & Carroll 1997:14).

Approaches to learning: Approaches to learning refer to the association between intent, motives and learning strategies among learners (Diseth 2002:221).

Educational or instructional outcomes: These are statements which describe what learners should be able to master (Wojtczak 2002:238).

Efficacy: The ability to produce the necessary or desired result (Wojtczak 2002:238).

Facilitator: In the new educational milieu the role of the "teacher" or the "lecturer" required revision. Facilitating learners' learning educators become the "facilitator" of learning (Neville 1999:393).

Scholastic Aptitude Test (SAT): The SAT is a group test constructed to measure academic intelligence or scholastic aptitude (Claassen *et al.* 1991:1).

Interactive education: Interactive education or interactive pedagogy is the process in which learners are induced or encouraged to work cooperatively in a social environment which accommodates individual differences (Garcia & Alban-Metcalfe 1998:176).

Interactive learning: Acting or capable of acting on each other/one another to gain knowledge and comprehension through experience or study (*The American Heritage Dictionary of the English Language* 2000).

Learner-centred education: It is an educational strategy in which it is expected of the learners to accept responsibility for their own learning.

The focus is on active involvement of the learners in the acquisition of information and skills (Division of Educational Development 1996).

Learning guide: The learning guide is a structured medium that facilitates learning, designed to direct learners through a series of learning activities to achieve specified outcomes (Harden *et al.* 1999:248).

Learning styles or cognitive styles: Learning styles refer to the preferred way in which an individual or group learn, organise and use knowledge to understand their environment (Anderson 2001:1) or the manner in which information is processed (Diseth 2002:219).

Self-efficacy: It is individuals' beliefs about their performance capabilities in a specific context, task or domain (Linnenbrink & Pintrich 2002:315).

1.11 ARRANGEMENT OF THE REPORT

The course of the investigation, the methods used to find solutions, and the outcome of the study will be reported on as follows:

In this chapter, Chapter 1, a brief introduction and background to the study were given.

Chapter 2, **Academic performance: related factors and education strategies,** contains a report on the literature study. Academic performance, academic competence, and factors facilitating or constraining learners' learning are discussed. Innovations in the field of interactive instruction in higher education, which received special attention, are explained in detail.

Chapter 3, **Research design and methods**, provides a description of the research methodology applied in the investigation. Theoretical aspects of the design are discussed, the experimental instruments, The Learning Preference Inventory, the pre- and the post-intervention test, as well as the questionnaire used as the method to collect data receive attention; the reasons for using the particular methods are put forward; and the course of the study is explained.

In Chapter 4, **Results and findings** of the experimental study are presented. The outcome of the study is provided, namely academic performance and an interactive educational strategy with a learning rather than a teaching approach.

In Chapter 5, **Discussion and recommendations** pertaining to the study and in particular to the outcome are dealt with. In this chapter specific recommendations regarding the potential use of the educational strategy and possibilities for further research are made.

1.12 CONCLUSION

With the advantages well documented, it was evident that interactive instruction should become an integral part of radiography education. Thus to explore the impact of an interactive education strategy on radiography education seemed meaningful. The next chapter, the report on the literature, serves as a foundation for and further enlightens the issues associated with the problem statement. The potential solutions of the problem briefly referred to in the introduction receive special attention. An overview of factors enhancing or hindering academic achievement and the concomitant education strategies to promote academic performance which follow, therefore seem appropriate.

CHAPTER 2

ACADEMIC ACHIEVEMENT: RELATED FACTORS AND EDUCATIONAL STRATEGIES

2.1 INTRODUCTION

Educational researchers have been exploring empirical and practical issues related to the academic advantages and disadvantages that have resulted from the changes in higher education, i.e. increased access to higher education through open admission and affirmative action, commitment to diversity and the paradigm shift from teaching to learning, to mention but a few (DeZure 2000:2). These changes have similarly influenced learners' academic progress in radiography education and thus it became essential to explore strategies that will improve academic success.

The expectation that interactive instructional efforts (NQF 2000:8; Chase & Geldenhuys 2001:1072; Kumar 2003:1) by means of a learning guide (Harden *et al.* 1999:248) and the accommodation of learners' learning styles (Ferguson *et al.* 2002:953; Steele *et al.* 2002:225) could make a difference in learners' academic performance, as noted in Chapter 1, has been explored in the present study. The fundamental principles related to the impact of an interactive education strategy in radiography education are academic performance, academic competence, factors that facilitate or constrain learners' learning and, as a result, academic achievement. An effort was made to define these concepts and to determine the significance thereof in the investigation at hand. Numerous articles published in educational journals address the aforementioned concepts.

2.1.1 Search criteria

The databases Academic Search Premier, Ebscohost, the Educational Resource Information Centre (ERIC), Medline, and OVID were used to conduct the literature search that covered the time period 1999 to 2003. The search criteria were "academic ability, academic achievement, academic competence, medical education, interactive education, learner performance, and heterogeneous/diverse classes". On the basis of their tendency to address the relevant topics, the following journals were examined: *Academic Medicine, Advances in Physiology Education, British Medical Journal, British Journal of Educational Psychology, Educational Psychologist, Journal of Applied Psychology, Journal of Educational Psychology, Journal of Medical Education, Journal of Educational Psychology, Journal of Experimental Education* as well as *Medical Education* and *Medical Teacher.* The reference sections of appropriate articles were searched for further relevant publications. To explain the course and foundation of this study, various perspectives from the literature on academic achievement will subsequently follow.

2.2 ACADEMIC ACHIEVEMENT

Academic achievement, which is the extent of success reached in education, has been the focus of widespread educational research. For the purpose of this review, academic achievement, academic performance and academic success are used interchangeably. In addition, it seems that academic achievement and academic competence are interwoven, since the possible attributes reported in the literature are similar (DiPerna & Elliott 2002:293). "Academic competence" is defined as a multidimensional concept consisting of learners' skills, attitudes, and behaviour contributing to academic success (DiPerna & Elliott 2002:293). In view of the fact that effective learning is the crux of academic achievement, the nature of effective learning will be looked into to explain academic achievement.

Behaviour as an essential part of learning is accentuated by Wentzel (1991:1-24) in a literature survey of both theoretical and empirical work on social responsibility and academic achievement. The author points out that learners' social responsibility could improve learning if positive interactions with facilitators are promoted. The idea of academic enablers developed from the work of the researchers Wentzel and Watkins (2002:366), as quoted in DiPerna and Elliott (2002:293), who explored the connection between non-academic learner behaviour and academic achievement. These authors saw academic enablers as attitudes and behaviours that allow learners to participate in, and ultimately benefit from, academic instruction during contact time with facilitators. The mention of "interaction" emerges as a potential academic enabler or, in other words, an enhancer of learning. Referring to "interaction" as an academic enabler will be addressed in later paragraphs.

As early as 1981 Krouse and Krouse (1981:151) referred to under-achievement as a complex interaction between three factors, namely a weakness in academic skills such as reading, note-taking and taking exams; a lack in behavioural self-control skills such as self-monitoring; and ineffective arrangement of study time. The complexity of underachievement mentioned by Krouse and Krouse (1981:151) and the role of social responsibility noted by Wentzel (1991:1-24) as well as by Wentzel and Watkins (2002:366), limit the impact facilitators could have on learners' learning. Sayer, De Saintonge, Evans and Wood (2002:643) investigated the causes of academic failure in undergraduate medical learners and they also found that the grounds for failure are diverse and not always academically based.

According to Boyle, Duffy and Dunleavy (2003:269) educational researchers acknowledged the intricacy of learning and explored the different aspects of learning to a greater extent. Traditional views of effective learning were typified by the passive transfer of information from teacher to learner (Boyle *et al.* 2003:268), while constructivism - which refers to a new philosophical advance to learning - includes active, deep and self-regulated approaches to learning. Boyle *et al.* (2003:270) state: *Deep learning, self-regulated learning, intrinsic motivation and a constructivist conception of learning are regarded as preferable to surface learning, teacher-centred learning, extrinsic motivation and an objectivist conception of learning.*

To look into these factors that influence effective learning and, as a result, are factors associated with academic achievement seemed important and will follow in the next paragraph.

2.3 FACTORS ASSOCIATED WITH ACADEMIC ACHIEVEMENT

Pintrich and De Groot (1990:35) investigated predictors of academic achievement in primary education. They indicated that behaviour, among others, is an important part of learning. Therefore effective learning, known to be the foundation of academic achievement, was looked at. However, the intricacy of learning was not seen as a factor easily altered. Substantial empirical evidence indicates that not only behaviour, but also a variety of environmental factors exist that influence learning (DiPerna & Elliott 2002:295; Lam, Irwin, Chow & Chan 2002:234; Linnenbrink & Pintrich 2002:313). In addition, Morrison (2001:7) points out three factors associated with effective learning, namely learners' academic orientation; their level of involvement; and the extent of stimulus by learning-related activities.

Even though it is not in the scope of the present study to address all of these factors, an attempt was made to identify the factors facilitators can control through interactive instruction during contact time with learners, namely cognitive ability, academic self-regulation, self-efficacy, motivation, approaches to learning, study skills and learners' learning styles or preferences. These were considered and will be described in the paragraphs that follow.

2.3.1 Cognitive ability

Various definitions of cognitive ability or intelligence have been presented in previous research. For example, intelligence is the ability to adapt, select and reform one's environment and includes the following basic elements, namely problem-solving, verbal ability, and social factors (Sternberg & Sternberg *et al.* in Claassen 1991:2). Cognitive ability or intelligence consists of aptitudes (Gardner in Diseth 2002:220), behaviour (Sternberg in Diseth 2002:220), involves reaction time (Kline in Diseth 2002:220), and is influenced by physiological and educational-experiential factors (Undheim in Diseth 2002:221). Although Diseth (2002:219) states that a combined model of intelligence is not evident, the author distinguishes it from other concepts like cognitive style or learning style. McLean (2001:405) states that academic ability is influenced, among others, by the learner's personal characteristics, the learning environment and the kind of curriculum. The author also indicates that cultural and political factors influence how a learner performs in a given situation.

Can academic achievement in higher education be predicted by aptitude tests that indicate intelligence or academic ability? The question concerning the value or answerability of this standardised ability measures such as the Scholastic Aptitude Test (SAT) gave rise to efforts to improve the prediction of academic achievement in higher education by evaluating the impact of academic self-regulation on learners' learning (Claassen 1991:120). Ruban *et al.* (2003:270) state that standardised measures, for example the SAT, have restricted value in predicting higher education grades. A rising tendency at all levels of education avoids dependence on standardised measures of aptitude and achievement and places more weight on self-regulated learning to ensure academic success (Pintrich & De Groot 1990:36; Barron & Norman in Ruban *et al.* 2003:270).

2.3.2 Self-regulation

"Self-regulation can be defined as self-generated thoughts, feelings and actions for attaining academic goals" (Zimmerman 1998:73). In addition, the definitions of self-regulated learning have three characteristics: the use of self-regulated learning strategies, motivation, and the reflection on learning effectiveness by the learners themselves (Zimmerman 1990:5). Qualitative and quantitative differences exist between high and low academic achievers and the use of cognitive and self-regulatory study strategies can be used as a reliable measure to predict academic success (Gettinger & Seibert 2002:353). The dimensions and processes of self-regulation include, among others, motivation, study method, time management, behaviour, environmental structuring, and social help-seeking (Zimmerman 1998:75).

Zimmerman and Martinez-Pons (1988:284) used a structured interview to compare academically successful and regular learners' use of self-regulatory approaches to learning in secondary school learners and found that a strong relationship exists between learners' use of self-directed or self-regulated learning strategies and their academic achievement. The authors propagate that self-regulated learners are motivated, they see themselves as self-efficacious, and they function in environments that optimise acquisition of knowledge.

Although researchers decided on the theory and measuring of academic self-regulation, differences in opinion on the construct exist (Ruban *et al.* 2003:271). According to the authors, these differences have implications for interventions on learners with learning problems. The authors question if high and low achievers use the same self-regulatory strategies when learning and if a relationship exists between this approach and academic achievement for learners with and without learning difficulties. Ruban *et al.* (2003:275) conducted a study in which 470 undergraduate learners at a research university in North America participated to investigate the relationship between learners' use of self-regulated learning strategies and their academic achievement. The authors used a structural equation model approach and found that self-regulation has an impact on academic achievement.

At the University of Hong Kong the authors Leung, Lam and Hedley (2001:1072) supported the above-mentioned findings by stating that, for effective learning, learners must be in charge of their own learning. Davis and Harden (1999:139) expanded on the issue of self-directed or self-regulated learning by arguing that, if this approach leaves learners with gaps in their knowledge and skills, the learners learn how to identify their own learning needs and, with time, they can remedy the learning deficits for themselves.

Kitsantas (2002:109) also compared the self-regulatory processes used in test preparation by high and low test scorers in 62 undergraduate psychology learners at Florida State University. The author found that high test scorers (mean=0.93, ± 0.38) used more self-regulation processes than low test scorers (mean=0.53, ± 0.41). The author added that self-regulation positively affected test performance, self-regularotory skill and self-efficacy beliefs predicted test scores and self-regulated learners were also self-motivated .

Zimmerman in Sanz de Acedo Lizarraga *et al.* (2003:60) indicates that the trend of self-regulation develops in three phases, namely enthusiasm, to be in control of the process, and self-reflection during a learning activity.

Any learning activity or intervention with the aim of improving academc performance should therefore include forethought, control and self-reflection in order to assure self-regulation and, as a result, enhanced cognitive ability. Sanz de Acedo Lizarraga *et al.* (2003:65) conducted an experimental study on secondary education in Spain and found that an educational model that encourages forethought, control and self-reflection improved the use of self-regulation skills and, as a result, also academic achievement. Their findings represent an example of how to use educational strategies to prevent intellectual deficiencies. Zimmerman *et al.* (1988:284) state that self-regulated learners plan and organise their own learning. The authors expand on self-regulation and state that these learners are independent, intrinsically motivated and self-efficacious.

2.3.3 Self-efficacy

Self-efficacy is defined as individuals' beliefs about their performance capabilities in a specific context, task or domain (Linnenbrink & Pintrich 2002:315). The findings of Gully *et al.* (2002:147) and the views of Davis and Harden (1999:130) indicate that cognitive ability predicts self-efficacy, which is a person's potential to perform a task, and which serves as motivation to learn (Zimmerman 1990:6). Gully *et al.* (2002:147) further expand and state that "cognitive ability" indicates the skill to understand, process, and relate information. Their results testify that ability is positively related to self-efficacy, a fact also noted by Linnenbrink and Pintrich (2002:313), Pimparyon *et al.* (2000:363) and Zimmerman (1998:81).

Sobral (2001:508) conducted a study on second-year medical students at the University of Brasilia in which the aim was to evaluate reflection on learning in relation to measures of learning approaches and academic achievement. Sobral (2001:512) found that high achievers showed a high level of perceived personal efficacy. The author expanded on the issue of self-efficacy by stating that self-efficient learners reflect on both the process and the content of learning, which help them to control their learning and their academic performance. Self-efficacious learners also tend to set high goals, do self-evaluation and persist under difficult conditions in contrast with those who doubt their own ability (Kitsantas 2002:103).

Sayer *et al.* (2002:643) studied the causes of academic failure in undergraduate medical learners and encouraged learners to take responsibility for their own learning. In taking responsibility for their own learning learners thereby promote self-efficiency and autonomy, skills that support independent learning and as a result lead to increased motivation and improved examination scores. The apparent inability of radiography learners to be self-efficient in the learning process could be explained by the experiences of Holsgrove *et al.* (1999:99) with learner-centred learning of learners from diverse backgrounds. They observed that a simple shift from teacher to learner was not possible. This explanation for poor pass rates among radiography learners could possibly be resolved through guidance by facilitators. This claim is confirmed by Ames and Archer (1988:261) in their experimental study on secondary education, academically advanced learners. They state that research from diverse perspectives shows that learning is enhanced when classroom environments encourage learner involvement, personal responsibility, and when learners themselves are committed to understanding and learning.

Pintrich and De Groot (1990:35) found that higher levels of self-efficacy correlated with higher levels of cognitive strategy and also higher levels of self-regulation and hence academic achievement. Since self-efficacy, self-regulation of cognition and motivation emerged in a correlation study done by the authors as factors associated with academic achievement, motivation was further looked into.

2.3.4 Motivation

Learners' failure to learn is also due to issues other than their learning capability, for example lacking motivation (Zimmerman 1998:73). Davis and Harden (1999:130) and Gully *et al.* (2002:147) state that, if learners are actively involved in the learning process, it leads to an intrinsic motivation to learn. Linnenbrink and Pintrich (2002:313) indicate that motivation plays an essential role in academic competence and it is seen as a key element in academic performance. Davis and Harden (1999:130) share this view. They suggest that taking responsibility for one's own learning enriches the learning experience, while presenting an intrinsic motivation to learn.

According to Linnenbrink and Pintrich (2002:314), previous research on achievement and learning did not integrate cognition and motivation. Only later did researchers recognise that motivational and cognitive factors jointly influence learning and hence achievement. These authors further suggest that motivation can vary depending on the situation or context in the classroom and that multiple ways to motivate learners exist. Here the classroom environment emerges as a possible area in which learning could be enhanced.

Cleave-Hogg and Rothman (1991:456-474) expound on the value of motivation. They found that the environment in which education takes place plays an important role in learner motivation; attending non-interactive classes is a negative discouraging factor in learning. Studies undertaken by Chickering (1980:5) also showed that learners' progress in becoming autonomous learners and attaining success is hindered by lecture-centred curricula. Pike (1994) in Vaughn, Del Rey and Baker (2001:40) says that educators have no influence over learners' motivation, but can only develop the environment where learners will motivate themselves through, among others, practical application, responsibility and active learning.

As recently as 2003 Kumar (2003:20) conducted an experimental study in which his findings were that interchange between facilitators and learners advances active learning and increases attention and motivation. Kumar (2003:24) states that increased stimulation and motivation are the critical ingredients for learning and are often more important for retention than intelligence. The author's findings were based on an experimental study conducted on first-year dental learners at an Institute of Health Sciences in Nepal. To further expand on motivation, Boyle *et al.* (2003:268) state that learners with a deep approach to learning are motivated by intrinsic concern, while surface learners in contrast focus on memory and are motivated only by the desire to obtain a qualification.

2.3.5 Approaches to learning

Except for behaviour and motivation previously described, the manner in which learners approach learning also has an effect on academic achievement. Approaches to learning refer to the association between intent, motives and learning strategies among learners. However, there are many factors that determine how learners approach learning, for example the teaching approach, the instruction design, the assessment of learners' learning and the content of the curriculum (Entwistle in Pimparyon *et al.* 2000:359; McLean 2001:401).

Diseth (2002:221) identifies mainly two approaches to learning, namely a "surface approach" which is rote learning with the intention to reproduce information to avoid academic failure or a "deep approach" to learning which is based on understanding and interest in information. Gordon and Debus (2002:484) conducted studies on how students learn and also indicate that there are two ways in which learners approach their learning. Some learners follow a surface approach to learning and are concerned mainly with remembering facts in order to do well in their examinations or, in other words, the learners aim "to meet minimum requirements with minimum effort". Alternatively, some learners have a deep approach to learning and are concerned with comprehensive learning and try to understand the meaning behind what they learn (Gordon & Debus 2002:484; Marton & Saljo in Pimparyon *et al.* 2000:359). In addition, Boyle *et al.* (2003:268) made the following statement: "Deep learning has been one of the most influential constructs to emerge in the literature on effective learning in higher education". Ferguson *et al.* (2002:957) through their systematic survey of the literature on factors associated with academic success in medical school also reported on a deep and surface approach to learning, but in addition, reported on a strategic approach. According to these authors a deep approach to learning is stimulated by intrinsic motivation, career interest and personal understanding and strategic learning is encouraged by a desire to be successful. Alternatively, a surface appraoch to learning is motivated by a fear of failure and these learners tend to simply memorise information.

Gordon and Debus (2002:494) in their study investigated the issue if surface approaches can be reduced and deep approaches to learning increased among teacher education university learners in Australia. The results indicated that the use of deep approaches to learning increased when teaching methods encourage the use thereof. Pimparyon *et al.* (2000:361) state that a connection between approaches to learning and the educational environment are factors associated with academic achievement. The authors based their findings on a quantitative experimental study conducted at a Thai nursing college in Bangkok. The aim of the study was to assess how these learners saw their learning environment. The relationship between their approaches to learning and their academic achievement was reported on. According to Pimparyon *et al.* (2000:361), the learning environment might motivate some learners highly to engage in learning while, at the same time, having no positive influence on other learners.

Diseth (2002:222) compared academic achievement, based on examination grades, with approaches to learning in undergraduate psychology learners at the university of Bergen in Norway and, in contrast to Gordon and Debus (2002:494), found that neither intelligence nor approaches to learning in his sample predicted academic achievement. The differences in commitment reflect differences in learners' use of learning approaches; some learners may learn better from some methods and styles of teaching than others. Learners' perceptions of the learning environment affect their choice of learning approaches, which correlate with their academic achievement (Diseth 2002:221). However, using only the teaching approach or the learning style as a predictor of academic achievement is not adequate in ensuring learners' academic success (Pimparyon *et al.* 2000:361). Entwistle in Pimparyon *et al.* (2000:359) states that suitable interventions can facilitate a deep approach to learning and it is the responsibility of the facilitator to construct learning experiences that provide opportunities for the development of critical thinking.

2.3.6 Study skills

For the following discussion, the terms "study skills" and "study strategies" are used interchangeably. Study skills include the ability to acquire, record, organise, synthesise, remember and use information (Hoover & Patton 1995 in Gettinger & Seibert 2002:350). Pressley and Afflerbach in Gettinger and Seibert (2002:352) identify the following basic study skills, namely the learner forms an overview before reading; selects and links important information; uses prior knowledge; and changes strategies to optimise learning.

Study skills contribute to both achievements in non-academic and academic situations (Devine 1987 in Gettinger & Seibert 2002:350). Several researchers as documented in Gettinger and Seibert (2002:350) indicated that weak and restricted study skills are implemented by low-achieving learners, in contrast with high achievers who make use of a variety of study strategies in an accommodating way. Academic ability is also associated with the knowledge and use of effective study skills (Gettinger & Seibert 2002:350). According to the authors, capable learners may be academically at risk because of the lack of effective study skills and not because of the lack in cognitive ability.

The Committee for Tutorial Matters (CTM 2001b:12) state that learners use basically two cognitive strategies of learning to direct and monitor their own learning process, in other words, how to learn and a manner of thinking. Furthermore, if the learner is aware of the potential advantage of a study skill, it will be used in various settings (Gettinger & Seibert 2002:350).

To acknowledge the influence of study skills on learning seems worthwhile and are confirmed by the following remark by Gettinger and Seibert (2002:352): "Study skills are fundamental to academic competence. Effective study skills are associated with positive outcomes across multiple academic content areas for diverse learners". The authors see study skills as an academic enabler that function as an important tool for learning; they include a range of cognitive skills and processes that increase the effectiveness of learning. The authors, however, indicate that learners with low academic competence often demonstrate ineffective study skills in that they play a passive role in the learning process and rely on facilitators to control their learning.

Thompson and Geren (2002:398) state that facilitators play a critical role in the early identification of learners at risk of academic failure. According to the authors, these learners should be explicitly informed of cognitive strategies and study skills that promote academic success. Since effective study skills should include cognitive activities that help in the acquisition and retention of information, interactive activities with facilitator guidance to overcome these ineffective study skills therefore seemed appropriate.

Although learners were expected to develop study skills independently in the past, educational psychologists and teachers had neglected the issue of teaching study skills (Zimmerman 1998:73). The CTM (2001d:12) provided a solution: According to the CTM, knowledge should be structured to improve cognitive skills and analytic thinking. Learning experiences should be organised in such a way that the learner is able to demonstrate the ability to analyse, apply, synthesise and evaluate information in order to nurture effective study strategies.

Effective study skills reduce academic failure (Gettinger & Seibert 2002:362) and, for learners to be effective, they must know when, where and how to use these skills. The authors state that effective study skills can be taught and facilitators should scaffold the process until the learner has become skilled with the strategy. Although it is only one aspect of academic failure, research on study skills instruction and ways to improve learning should remain a high priority.

2.3.7 Learning styles

Research on learning styles has arisen along with research on effective learning (Boyle *et al.* 2003:269). Wigen *et al.* (2003:32) and Boyle *et al.* (2003:286) state that ineffective learning strategies, such as an undirected learning style, compare negatively with academic success, while a positive correlation between effective learning styles and academic success exists. The manner in which learners learn is varied and is related to differences in personality. It also changes in different situations and at different times. These patterns have been labelled as "Learning Styles", "Learning Strategies", "Learning Preferences" and "Approaches to Learning" (Wigen *et al.* 2003:32).

Ferguson *et al.* (2002:954) conducted a systematic survey of the literature on factors associated with success in medical school. They found that research has mostly focused on previous academic ability and that previous academic performance was a good but not a perfect predictor of academic achievement. The authors report that relatively little research has been done into the significance of learning styles associated with success in medical education and they point out that a strategic learning style is associated with success in medical training. Harden (2003:98) commented on the findings of Ferguson *et al.* (2002:954) and emphasised that learning styles "are believed to be significant predictors of success in medicine".

As early as 1969, Cronbach and Snow (1969) in Keri (2002:433) assumed that differentiating or adapting teaching to the needs of learners improves learners' academic achievement. They argue that teaching methods place varying demands on learners and they affect learners' learning in many different ways. These findings strengthen those of Gully *et al.* (2002:152) who found that failure to consider individual differences when designing education programmes may lead to less positive outcomes. To strengthen the possible approach to diverse learners, Troutman (1997-1998:16) as quoted in Growe, Schmersahl, Perry and Henry (2002:206) calls on higher education institutions to build on and acknowledge cultural diversity and to make sure that facilitators accommodate the learning styles of diverse learner populations.

The authors Boyle *et al.* (2003:270) examined different learning styles in Social Science learners at a British university. The relationship between meaning-directed, reproduction-directed, application-directed and undirected learning styles and academic outcome were investigated. The authors found a statistically significant positive correlation between a meaning-directed learning style and academic performance ($r=0.23$, $p<0.01$). Learners should therefore be encouraged to develop a helpful learning style, since it is recorded that an association between positive learning styles and academic performance exists (Martin *et al.* 2000:531). The authors used the learning style inventory of Entwistle, which was previously used in the evaluation of medical students. This inventory consists of three principles with four additional elements. The three basic principles are:

- An achieving scale which is characterised by well-organised study methods, a sense of competitiveness and a hope for success.
- A reproducing scale which represents a surface learning approach that is extrinsically motivated and curriculum-restricted.
- A meaning scale representative of an approach that results in deep learning and is intrinsic and academically motivated.

The four additional elements are comprehensive learning; operation learning; a versatile approach; and learning pathologies. Martin *et al.* (2000:530) assessed the relationship among clinical experience, learning style, and test performance in first-year medical students at the University of Leeds. The researchers found that test performance was related to well -organised study methods and experience was associated with a deep-learning style.

Wigen *et al.* (2003:32) also explored the predictors of medical students' academic success at a Norwegian University. The researchers used the Approaches to Studying Inventory (ASI) of Entwistle and similarly found that constructive learning styles positively correlated with academic success in their study. Sobral (2001:508) conducted a study on second-year medical students at the University of Brasilia in which the aim was, among others, to evaluate the connection of learning approaches with academic achievement. The author used a short version of Entwistle's instrument which focuses on Meaning Orientation and Reproductive Orientations, the findings of his work confirm that of Martin *et al.* (2000:531).

Furthermore, since learners have different learning styles, Vaughn *et al.* (2001:40) state that educators must use a range of active learning strategies, because learners need a variety of teaching methods to encourage learning and to address the different learning approaches. The authors found in their survey in a medical school in Cincinnati that learning experiences, teaching styles and the way in which information is managed, determine the learning styles learners use. And, most important, is that the preferred style can change, especially when the learner is exposed to changing teaching styles. By using a variety of teaching methods and styles, learners are exposed to both familiar and unfamiliar ways of learning. This variety of teaching methods and styles cause both tension and comfort during the learning process, which encourage more effective learning.

The inventories used by Martin *et al.* (2000:531), Wigen *et al.* (2003:32) and Sobral (2001:509) on learning styles are not directly comparable with the inventory of Rezler (1974) used in this study. The aim of the Learning Preference Inventory (LPI) conducted was not to compare certain learning approaches to academic success, but to determine the structure of the intervention to address learner diversity with regard to educational needs. The inventory included the following learning situations (see Table 2.1):

Table 2.1: Learning preference characteristics

Learning situation	Characteristics
Abstract	Preference for learning theories, principles, and general concepts, hypothesis generation and testing.
Concrete	Preference for learning specific, tangible information and skills; practical application.
Individual	Preference for learning on one's own; emphasis on self-review and reading.
Interpersonal	Preference for learning in groups and with others; values interaction with fellow-learners and with teachers.
Learner-structured	Preference for learning via learner-organised and self-directed tasks; values autonomy and self-direction.
Teacher-structured	Preference for learning that is directed by the teacher; learning goals that are defined by the teacher.

Source: Steele *et al.* (2002:227)

The aforementioned factors that influence learning all share an active, interactive and learner-centred perspective and decidedly support the use of interactive and learner-centred approaches over passive, lecture-centred strategies. A description of learner-centred, active and interactive learning; the potential use; critique against; and the relevance thereof will subsequently follow.

2.4 EDUCATIONAL STRATEGIES

DeZure (2000:2) comments in a report that "Three decades of lessons on teaching and learning" in higer education changed approaches to teaching and learning. The author states that many of the learner-centred and active learning strategies advocated 30 years ago are only now taking root. The author explains that there are at present preference for these methods, because changes in higher education necessitate these developments. An advancement that represents a shift from the lecturer to the learner, that is one that promotes and supports an active culture of teaching, is seen as a step forward.

Chase and Geldenhuys (2001:1071) found in their survey of learner-centred teaching in a large heterogeneous class that the learners subjected to interaction between facilitator and learner scored higher end-of-term tests marks than those where only lectures were given (p=0.001). McLean (2001:408) in addition states that past political and historical factors are responsible for the fact that learners are not prepared for higher education. The author points out the need for educators to be aware of the conception of learning these learners bring with them and that personal involvement and more effective learning strategies must be addressed.

2.4.1 Learner-centred learning

To achieve academic success, the Academic Planning and Budgeting Committee (APBC) of the TFS stated in April 2003 that the key to enhancing learning depends on academic institutions to create a learner-centred educational environment (TFS 2003:1): "The implementation of a learner-centred approach to education is of the utmost importance". This learner-centred learning entails a shift from the traditional teacher-centred approach to an approach in which the emphasis is on the learners and what they learn (Spencer & Jordan 1999:1280). The authors see learner-centred learning as a process that actively involves the learner and they allege that it promotes a deep approach to learning. Learner-centred education will be explained in the following paragraph.

Learner-centred education is an educational strategy according to which it is expected of the learners to accept responsibility for their own learning (Division of Educational Development 1996; CTM 2001a:20). As maintained by a Draft Planning Document of the Academic Planning and

Bugeting Committee (APBC) of the TFS (2003:2), learner-centred learning is explained as a milieu that assists the searching of knowledge through personal and interpersonal discovery. The main advantage revealed in this document, which is very important for the present study, is that the proposed learner-centred education addresses individual differences, learning styles, abilities and encourages feelings of efficacy.

The following examples of learner-centred learning are put forward by the above-mentioned document, namely combined group learning; individual research and discovery; resource-based learning; and problem-based learning. Problem-based learning is seen by Charlin, Mann and Hansen (1998:323) as an educational approach and not a single instruction method. The value if this learner-centred and active approach is based on the fact that learners become active builders of knowledge. Davis and Harden (1999:133) see learner-centred learning in the form of problem-based learning as a process that forces the learners to take responsibility for their own learning, a feature that prepares them for lifelong learning in health care.

Since Barr and Tagg (1995:22) suggest that facilitators should design a learning environment, which will yield better results, it is evident that the solution is enhancing learning centres around the facilitator's ability to create a learner-centred educational environment. Harden and Crosby (s.a.:10), by means of a survey of 251 lecturers in the medical school at the University of Dundee, identified the role of the lecturer in higher education and came to the conclusion that the move to a learner-centred approach required a fundamental shift in the role of the lecturer from "instructor" to the "facilitator" of learners' learning.

Van den Hurk, Wolfhagen, Dolmans and Van der Vleuten (1999:808) investigated the relationship between learning approach and achievement at a Medical School of Maastricht University, the Netherlands. They found that when learners are responsible for their own learning, they gain autonomous learning abilities and learn to become self-directed. The authors see self-directed learning as a process in which learners take the first step to identify their learning needs and apply effective learning strategies to reach the learning outcome. This independent and active learning is stimulated by discussing problems in small groups when unanswered questions serve as a guide for independence and self-directed learning.

Although it seems as if the former statement is the solution to the poor academic performance of learners in radiography, it was noted in Chapter 1 that a simple shift from teacher to learner was not possible (Holsgrove *et al.* 1999:99). The authors state that, through their experience with learner-centred learning in learners from diverse backgrounds, this shift was not possible. This proposed shift from lecturer to learner is part of the resistance experienced in the radiography programme under investigation and potential alternatives were considered. Since learners with academically deprived backgrounds require substantial support from facilitators and do not take responsibility for their own learning (Holsgrove *et al.* 1999:99) as propagated in learner-centred learning, this approach *per se* was not the sole solution for academic failure. In view of the fact that interaction between the facilitator and the learner was depicted as a positive encounter that contributes to academic achievement (Chase & Geldenhuys 2001:1072), active and interactive learning was looked into.

2.4.2 Active learning

"Active learning is the essence of effective studying. Good studiers are active learners, not passive recipients of fact and details" (Gettinger & Seibert 2002:353). Learning is a dynamic process in which the learner should play an active role. Educational researchers found that learners who actively take part in learning activities would learn more than students who are passive in the learning process, an opinion also supported by

Butler (1992:11) and Garcia and Alban-Metcalfe (1998:177). "Active learning", according to Boyer (2002:51), could include many "avenues" of education and allow learners to become lively participants who can direct their own learning. The value of active learning was highlighted (Harden & Crosby s.a.:10; Ames & Archer 1988:261; Wentzel 1991:15; Barr & Tagg 1995:15; Bitzer & Pretorius 1996:1; Davis & Harden 1999:130; Baxter & Gray 2001:396; Chase & Geldenhuys 2001:1071; Gettinger & Seibert 2002:352) and building on this important fact, Morrison (2001:7) and Kumar (2003:25) emphasise that the formal lecture creates a passive or superficial approach to learning.

Baxter and Gray (2001:396) also emphasise the importance of active learner involvement in speech and language therapists in clinical education that lead to a deep approach to learning in contrast with surface learners who only memorise and reproduce information. Their findings were based on learner feedback, which was positive to the more self-directed and active learning approaches. The significance of active learner involvement in the learning process is also emphasised by the research findings of Dolan, Mallott and Emery (2002:648) who indicated that first- and second-year learners in medical school who convey passive learning behaviour are potentially at academic risk. The authors stress the need to identify supportive interventions in future research to counteract this passive behaviour.

Barr and Tagg (1995:23) state that the traditional "Instructional Paradigm", which consists of formal lectures, is increasingly recognised as ineffective. The authors urge that this instruction approach should be replaced by a paradigm that produces learning. According to the authors, the learners are responsible for their own learning and become "co-producers" of learning, since they discover and construct knowledge for themselves. The authors recommend that an effective learning theory is based on an active and learner-centred approach and that the learning environment should support the fact that both the lecturer and the learner take responsibility for the same outcome, which is academic success. Barr and Tagg (1995:16) point out the following: "When two agents take such responsibility, the resulting synergy produces powerful results". The increasing importance of learner independence in medical education has moved the "centre of gravity" away from the lecturer towards the learner (Harden & Crosby s.a.: 3). But, on the other hand, the presence of a good lecturer may have more positive outcomes in improving learners' achievement than other, much publicised aspects such as class size (Harden & Crosby s.a.:3). For this reason, interactive teaching was, among others, seen as a potential enhancer of academic performance. This learner active and facilitator-learner interactive approach to education therefore follows.

2.4.3 Interactive learning

The shift of responsibility from educator to learner goes hand in hand with nurturing a culture of learning and guiding learners with a learning guide through the process of learning (CTM 2001c:3). Interactive education or interactive pedagogy is the process in which learners are induced or encouraged to work cooperatively in a social environment which accommodates individual differences (Garcia & Alban-Metcalfe 1998:176). "Interactive learning" means that the facilitator, through interaction, includes opportunities in a class for learners to talk, write or be engaged in activities in which they use new knowledge or skills. Gordon (2003:543) reports that, as far back as the 17th century, Dr Franciscus de la Boe Sylvius, a professor of medicine at the University of Leyden, the Netherlands, promoted interactive teaching by using one-to-one teaching in clinical settings. The need to address academic underachievement, using interactive education strategies such as classroom learning within a social context through interaction and guidance from facilitators, is validated by Garcia and Alban-Metcalfe (1998:177), Gettinger and Seibert (2002:350), Kumar (2003:20), and Wilke and Straits (2001:62).

The beliefs of previous authors referred to in Chapter 1, namely that learners with academically deprived backgrounds require more support and encouragement to take advantage of active learning and teacher support (Holsgrove *et al.* 1999:99), put emphasis on the value of an interactive educational approach. Chase and Geldenhuys (2001:1072) support this point of view and identify the advantages of interactive contact sessions observed during their survey of a class with a wide range of academic abilities.

More recently Kumar (2003:25), who states that interaction between the facilitator and the learner could have positive outcomes on learning, led the way to explore this interaction and the effect thereof on learning in radiography education. Pimparyon *et al.* (2000:364) state if the aim in education is effective and successful learning, educators should aim to create a supportive environment and also design and put into practice interventions to resolve unsatisfactory elements. The fact that low academic achievers are more dependent on active facilitator guidance sustains the importance of an interactive rather than only active educational strategy. The belief that an interactive educational strategy could improve the marks of low academic achievers is confirmed by the study of Cleave-Hogg and Rothman (1991:456-474), according to which learners were asked to indicate which factors supported and stimulated learning. The majority of the learners mentioned the relationship between the facilitator and the learner as the main positive influence in enhancing learning. Harden and Crosby (s.a.:8) also indicate that learners "traditionally expect to be taught" an approach that leads to learner passivity. But if teachers are enthusiastic and use interactive ways, it excites or motivates the learner.

Smits, Verbreek and De Buisonjé (2002:155) conducted a literature study on educational interventions that included a pre-test/post-test design. They found evidence that interactive educational methods in medical education are effective in changing performance among learners. The authors acknowledge the value of interactive sessions, but indicate that few well-conducted trials exist. Chase and Geldenhuys (2001:1071), who reported on learner-centred teaching in a large heterogeneous class with a wide range of academic ability at the University of Stellenbosch, found that learner interaction improved test marks in first-year medical and dental learners. The authors found that 82% of the participants agreed that interactive sessions was an effective way of learning. The end-of-term test marks were also higher in the interactive session group than those who only received formal lectures (p=0.0001).

Kumar (2003:24) states that increased attention and motivation enhance memory and further claim that increased stimulation through interaction is critical for learning and is more important for retention than intelligence. To summarise, active involvement enhances the learner's height of understanding and capability to put together and synthesise information. It also increases retention and a motivation to learn (Ames & Archer 1988:261; Davis & Harden 1999:133; Nasmith & Steinert 2001:48).

The value of interactive learning strategies is hence summarised as follows: First, an active learning process results in better mastering and a deeper understanding of subject content compared to simple memorisation (Davis & Harden 1999:130). Second, learners' critical thinking skills are enhanced when they are actively involved and they learn to be more effective learners (NQF 2000). Third, since learners differ in their preferred learning styles and abilities, the use of various learning activities could provide opportunities for learners to encounter some alternative way that could broaden their usual learning approach (Ferguson *et al.* 2002:953; Steele *et al.* 2002:225). Therefore, if educators can become skilful at using a variety of teaching approaches, the various learner needs and styles can be accommodated (Vaughn *et al.* 2001:41).

2.4.4. Learning guides

Spencer and Jordan (1999:1283) state that the learning guide is a potential enhancer of interactive learning. This active involvement of learners in the education process by using a learning guide is similarly emphasised by Strydom (1997:6), who proposes that: "Learning packages and materials are designed as a straight substitute for lectures", as well as a strategy to prevent learner passivity and promote independent learning.

Forced into a self-directed environment that is unstructured, the learner with little former knowledge on which to build needs guidance and relies on the facilitator to construct the learning process (Neville 1999:396). The learning guide is seen as a tool to assist both the learner and the facilitator as confirmed by Harden *et al.* (1999:248), who state that a learning guide is an instrument planned to facilitate learners' interaction with the different components of the learning programme. Learning guides play three roles in facilitating learning in that they manage the learning process, provide a focus for learning activities, and are resources that make available the necessary information concerning the learning theme. Learning is constructed according to the learning outcomes. The learning guide provides a foundation for either formative or summative assessment and the implementation of learning strategies is stimulated (Harden *et al.* 1999:248).

Since there has been a move from a teacher-centred to a learner-centred approach in education where it is expected of the learner to be more responsible and also to learn independently, the learning guide plays an essential role in guiding the learner through this process. To encourage learners to be active, the learning guide offers an interactive facet to learning and, as a result, enhances the learning experience. Learning guides make a major contribution to efficient and effective teaching and learning (Harden *et al.* 1999:256). The authors conclude that the key features of learning guides are that they are essential in the education process; they are informative; lead to motivation; and are interactive, with active participation of the learner.

The CTM (2001b:4) highlights the role of the learning guide: The outcomes-based learning guide is the product of a structured and planned process in which outcomes and assessments are connected; the content is integrated by means of learning strategies to facilitate learning. By using the learning guide, learners can make the best possible use of available learning opportunities by adjusting these opportunities to their own needs. According to the CTM (2001b:5), the learning principles for learning guides are that learners need structure and direction.

2.5 SUMMARY AND CONCLUSION

Low academic achievers frequently continue with little guidance or specific educational interventions to improve their performance; their learning problems are not attended to; and their learning environment remains unchanged, leading to repetition of failure (Sayer *et al.* 2002:643). After initiatives to advance increased access to higher education, the authors emphasise the need for increased educational support for learners and point out that little information about successful strategies for dealing with academic failure is available. Growe *et al.* (2002:205) further summarise the motivation for and significance of the present study: Facilitators should face the challenge of increasing diversity and stay committed to an understanding of education. The culturally diverse classroom should be seen as a resource to be developed and higher education must be prepared to meet the learning needs of culturally diverse populations. These authors further emphasise that strategies must be designed to educate learners in an environment that enhances learner achievement. This last statement underscores the overall goal of the present study.

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Academic achievement was described in this chapter and the problem of learner diversity briefly touched on. In summary, both experimental and correlation research suggested a positive outcome on academic performance if interactive instruction and the acknowledgement of different learning styles were included in the educational approach. Although only three articles commented on diverse learner populations, namely those by Chase and Geldenhuys (2001:1072), McLean (2001:402) and Gettinger and Seibert (2002:350), these contributions elucidated a variety of potential enhancers of academic achievement - factors which informed and influenced the empirical approach to the present study.

From the literature review it is concluded that academic achievement is a multifaceted concept in which academic ability, self-regulation, self-efficacy, motivation, approaches to learning, study skills, and learning styles play a part. Although academic achievement is complex, academic performance could be improved if both the facilitator and the learner are actively involved in the learning process (Bitzer & Pretorius 1996; NQF 2000; Chase & Geldenhuys 2001; Kumar 2003; Sanz de Acedo Lizarraga *et al.* 2003). For that reason, if conventional lectures in radiography are replaced by structured interactive sessions (SIS) that accommodate learner diversity; motivate learners; provide guidance on the use of effective study skills; encourage academic self-regulation; and promote a deep approach to learning, the goal of this study can be reached. In other words, help learners to become masters of their own learning. Brody (1994:68) states that innovative instructional interactions built into the curriculum that individualise the educational approach will improve educational outcomes.

The next chapter, Chapter 3, entitled *The research design and methods*, will explain the empirical approach and provide a description of the research methodology that was used to achieve the aim.

CHAPTER 3

RESEARCH DESIGN AND METHODS

3.1 INTRODUCTION

In an attempt to enhance academic achievement in the radiography learning unit at hand, the investigation used several theories from the field of interactive learning, as described in the previous chapter. As a result the focus was not only on active learning, but also on interactive learning, an education strategy which implies that both the facilitator and the learner were joined in an effort to manipulate the learning environment. The educational intervention was thus designed to incorporate the principles of active learning with facilitator guidance. The arrangement of these principles and their application are discussed below.

3.2 STUDY DESIGN

This study investigated the effect of an interactive approach of teaching, as well as learners' learning preferences and attitudes towards interactive learning and academic performance. The study design was fourfold (see Figure 1.1): First, a Learning Preference Inventory (LPI) was conducted (see Appendix I) to determine the appropriate education strategy and to arrange the structure of the educational intervention. Second, learners were divided into three groups, namely a formal lecture group, a self-activities group and a self-study group. Third, an experimental study method was developed to quantify improvement in learner performance before and after an interactive educational intervention (Appendices II and III). Fourth, a descriptive qualitative study in the form of a research instrument (Questionnaire: Appendix IV) was used to evaluate the learners' perception of the interactive approach to education during the intervention.

3.3 TARGET GROUP

The target group, a convenience sample, included 30 second-year learners from the programme Diagnostic Radiography at the TFS in the learning unit Radiographic Practice II (RAD 20 at) in 2002. All learners participating in the study completed the themes "Skull and cranial bones" and "Facial bones" as part of the educational offering of the School of Radiography. Prior to this experience, the learners had been exposed to forms of formal instruction during their first year as learner radiographers. Interactive instructional methods were not used and were seen primarily as a supplement to more traditional forms of instruction.

3.4 PROCEDURE

The ensuing paragraphs will describe the procedure of the study and provide a description of the methods used. Theoretical features of the design will be discussed, as well as the experimental instruments. The LPI, the pre- and the post-intervention test, and the questionnaire used as the method to collect data will receive attention. Al learning material was in English, but discussions with the facilitator could be in Afrikaans.

3.4.1 Learning preference inventory

The educational intervention strategy was developed based on the Rezler Learning Preference Inventory (Rezler 1974), which all the second-year learners completed before participation in the study. Research into learning preferences demonstrates that individuals differ in their preferences and approaches to learning and that no single strategy is optimal. The LPI reflects preferences for learning situations and conditions. Each item consists of six words or sentences to be ranked one to six. Each item contributed to different preferred learning situations, divided into contrasting scales on three dimensions, namely abstract/concrete; individual/interpersonal; and learner-structured/teacher-structured (see Table 2.1).

3.4.2 Division of groups

The division of groups was based on previous academic records. These records were based on the avarage marks of a formal test and Objective Structured Clinical Evaluation (OSCE) obtained in the first semester. The learners' names were sorted according to their average test scores obtained. Therafter the learners were divided into three groups consisting of an equal number of high-level, average, and low-level academic performers (see Appendix V). The three groups were subjected to different learning conditions which were:

- Formal lectures.
- Learning self-activities.
- Independent self-study.

Two learners assigned to the self-study group indicated that they felt insecure to study independently and requested to be part of the formal lecture group. The final sample sizes for each condition were 11 for formal lectures and learning self-activities and eight for independent self-study. The radiographic anatomy and positioning of the skull and cranial bones were covered by all three groups.

3.4.3 Learning content

The themes covered during the study, i.e. the skull, cranial and facial bones were part of the curriculum and relevant for the practical application of projections during experiential learning and gained competence in the clinical settings. The learning content consisted of two parts, namely radiographic anatomy and radiographic positioning of the skull and cranial bones. The radiographic anatomy included an anatomical overview of the cranial bones, the sutures of the cranium, joint classifications, and an anatomy review with radiographs. The radiographic positioning part involved skull morphology, cranial topographic landmarks, skull positioning lines, postioning considerations, basic and special projections, and evaluation as well as critique of skull radiographs. All three groups used the textbook entitled *Textbook of Radiographic Positioning and Related Anatomy* (Bontrager 1997:323-384) as their primary text and were informed by similar stated learning outcomes. The information was developed carefully to ensure that all the learners received identical information on the procedure and instructions of what was expected of them. All the groups were told to spend their time as effectively as possible and were informed that they would take a pre-test. The lecturer for both themes and for all the sessions was the same person.

3.4.4 Formal lectures

All of the learning content was presented to the formal lecture group (n=11) in the traditional lecture format by the researcher. The theme was covered in a series of three-hour sessions on four consecutive days. The lecture content obtained from Bontrager (1997:323-384) was introduced by means of ©*PowerPoint* slides (see Appendix VI), which contained anatomical sketches of relevant structures in the skull, keywords of important facts, patient projections, and radiographs to illustrate optimal views and radiographic images. The learners were passive observers and no interaction was pursued. The learners were expected to memorise the content and to prepare for the pre-test on the fifth day of the week scheduled for the survey.

3.4.5 Self-activities

The self-activities were written exercises that the learners (n=11) worked on during the same scheduled class sessions as the formal lecture group and it covered the same learning content as the formal lecture and independent self-study groups. The self-activities included a variety of different types of problems, namely "Fill-in-the-blank"; short answers; tables which had to be completed; and figures which had to be labelled (see Appendix VII). These were all oriented towards a set of explicit learning outcomes presented with the activities and were similar to those of the formal lecture and the self-study groups. The activities required the learners to extract information from the reference textbook (Bontrager 1997:323-384). The assigned group was not allowed to interact with either the facilitator or the co-learners. The learners were expected to complete the activities in the scheduled four days and then learn the content thereof to prepare for the pre-test on the fifth day.

3.4.6 Independent self-study

The self-study group (n=8) received identical outcomes as the formal lecture and the self-activity groups (see Appendix VIII). No further guidance was provided by the researcher and no contact with other learners were allowed. The learners were referred to the information in the above-mentioned textbook. They were expected to work through the theme during the same scheduled four days and then learn the content thereof to prepare for the pre-test on the fifth day.

3.4.7 Pre-test

Pre- and post-intervention test scores measured the extent to which the learners' academic performance increased. The pre-test was conducted on the fifth day of the study. In the preceding four days the formal group learners were expected to memorise the content of the formal lecture and to prepare for the pre-test. The self-activities group was expected to complete the activities in the scheduled four days and then learn the content thereof to prepare for the pre-test and the self-study group was expected to work through the theme during the same scheduled four days and then learn the content thereof to prepare for the pre-test on the fifth day. All learners wrote the same pre-test. The test consisted of a collection of 60 questions from a published review guide commonly used by Radiography programmes at academic institutions (Bontrager 1993:217). These questions were written to have a single best answer. Learners were allowed 90 minutes to complete the test.

3.4.8 Structured interactive sessions

The pre-test was followed up one week later with the interactive education strategy, that is structured interactive sessions (SIS) which entailed self-reflective and learner-guide-oriented contact sessions that included all the learners. The structured interactive sessions were devised based on the results of the LPI (see paragraph 3.4.1). The results indicated that the majority of the learners preferred a concrete, interpersonal and teacher-structured approach to education. "Concrete" is a preference for learning specific, tangible information and skills and practical application. An interpersonal preference is for learning in groups and with others, while interaction with fellow-learners and with teachers is valued. A teacher-structured preference for learning entails a teacher-directed approach with learning goals and objectives that are clearly defined by the teacher (Steele *et al.* 2002:227).

The educational intervention is a multidimensional approach (Butler 1992:15; Abdelhamid 1999:1) which was designed by using principles from teaching theories with the following characteristics:

- Learner-centred learning (Chase & Geldenhuys 2001:1071; Division of Educational Development 2002:1; TFS 2003:2).
- Problem-based learning (Barrows 1986:482; Bernard, Mann & Hansen 1998:323; Greening 1998:12; Davis & Harden 1999:130).
- Self-directed learning (Baxter & Gray 2001:399).
- Resource-based learning (Division of Educational Development 2000:1).

- Reflective learning (Baxter & Gray 2001:397; Whittle & Murdoch-Eaton 2001:1075).
- Active learning (Boyer 2002:48).

It consisted of multiple components designed to allow for maximum participant and facilitator interaction by using the learner guide as source for individual activities, group activities, self-tests, simulations and problem-solving.

The intervention, which included all the learners (n=30), covered the theme the facial bones in a series of three-hour sessions on four consecutive days - the same as in the three subgroups. The radiographic anatomy and positioning of the facial bones were covered. The learning content also consisted of two parts, namely radiographic anatomy and radiographic positioning. The radiographic anatomy included an anatomical overview of the facial bones and an anatomy review with radiographs. The radiographic positioning part involved facial morphology, facial bone topographic landmarks, facial bone positioning lines, positioning considerations, basic and special projections, and evaluation and critique of facial bone radiographs. All learners used the *Textbook of Radiographic Positioning and Related Anatomy* by Bontrager (1997:359) as their primary text.

The theme was introduced through a formal interactive lecture (see Appendix IX), during which the learning outcomes and learning frame were provided. The theme was then extended by interactive teaching, which included several types of interactive learning exercises, activities, case studies, simulations, reflective self-tests, small group discussions and presentations. The overall education strategy was facilitated by means of the use of a learning guide (see Appendix X). The learning guide was designed to assist the learners with their learning and to ensure active involvement. Learners were given verbal instructions and written guidance on the use of the learning guide. The learning guide specified the learning outcomes; identified learning resources; contained activities to discover information; and provided opportunities for the learners to assess their own progress and competence through self-tests.

3.4.9 Post-intervention test

The post-intervention test was conducted on the fifth day of the scheduled time for the second phase of the study, which also entailed four days during which the learning theme, namely the facial bones, was introduced by means of structured interactive sessions, the educational intervention. The test furthermore consisted of a collection of 60 questions from a published review guide commonly used by radiography programmes at academic institutions (Bontrager 1993:217). These questions were also written to have a single best answer. The pre- and the post-intervention tests were similar in content and format and the learners were allowed 90 minutes to complete the test.

3.4.10 The questionnaire

The questionnaire was designed to evaluate the learners' perception of the effectiveness of the educational intervention. A set of demographic questions and measures of individual preferences were included in the questionnaire. The questionnaires were available in English and were distributed in class after the tests results had been revealed; learners were allowed to ask for clarification of questions they did not understand. They were asked to indicate their perceptions of how successful or effective the various teaching methods were upon their own learning. The questions, to which the answers consisted of a "Yes" or a "No" answer only, provided information about learners' perceptions, reactions, attitudes, feelings, and experiences. The use of a "yes/no" answer was decided upon in order to encourage a more objective approach to assessing the effectiveness of the different methodologies on their own learning.

3.4.11 The pilot study

The questionnaire was completed by 20 third-year learners in the same programme before it was used in the study. Ambiguous questions were corrected and difficult terminology changed to clearer terms.

3.4.12 Scholastic Aptitude Tests (SAT)

The learners' existing official SAT scores had been obtained from the administrator's office, collected as indicator of the cognitive ability of learners in order to determine possible associations between the SAT, the pre- and the post-intervention test scores.

3.5 METHODOLOGICAL AND MEASUREMENT ERRORS

A brief overview of how methodological and measurement errors were counteracted, follows:

- The researcher's preferences for methods of instruction might have influenced the approach to education. An LPI was used to gather additional information to identify possible learning style differences that might have influenced academic performance among learners and thus to select the most appropriate education strategy.
- The investigation was conducted in a relatively short period of time (three weeks) to exclude the influence of the development of knowledge, skills, and efficacy regarding the themes covered.
- Objective test questions and answers (one correct answer only) ruled out variations associated with the observer.
- Different knowledge and test levels between pre- and post-educational intervention were addressed by using standard learning material and internationally used self-tests.
- Completing the pre-test might have improved post-intervention test scores. Pre- and post-intervention tests were conducted three weeks apart to rule out the retention of interrelated knowledge.

- Considering each individual participant as his/her own control might have led to an invalid baseline being determined by previous test scores. This measurement error was excluded by using the learners' SAT scores to confirm academic ability.
- The research findings cannot claim to be representative of other settings. A comprehensive study and comparison of the relevant literature in Chapter 2 support the findings.
- The questionnaire might be inadequate and might have omitted key areas. Piloting the questionnaire to a different group (to avoid sensitising the learners) indicated possible shortcomings and these were rectified.

3.6 ANALYSIS

The Department of Biostatistics at the UFS was consulted for recommendations regarding the management of data and the processing and presentation of the results. All statistical analysis was conducted by the researcher, using a statistical package for Windows, namely Statistica Version 5.0 (Stat Soft Inc. 2001) and SPSS 11.0.0 (SPSS Inc. 2001). All numerical variables were presented as a mean with standard deviation and median. Categorical variables were summarised using frequencies and percentages. Significant changes in the pre- to post-intervention test scores within the different study groups were measured by means of a paired difference t-test. The ANOVA method (Analysis of Variance) was used to compare the pre- and post-intervention test scores of the three subgroups. An ANOVA was also used to compare the improvement in test scores between the three different intervention groups. Correlation coefficients were calculated to determine the strength of association, if any, between numerical variables. Tests for normality and homogeneity of variances were conducted.

3.7 ETHICAL ASPECTS

Informed consent was obtained from all the learners. On the consent forms (see Appendix XI) the learners gave permission for the access of their official ASAT scores from the administrator's office and that their test marks might be used as a measure to assess improvement in academic achievement. Learners were assured that all information collected would be treated confidentially. The results and benefits thereof were shared with the learners. The Ethics Committee of the Faculty of Health Sciences at the UFS reviewed the protocol and gave consent for the investigation to be conducted (see Appendix XII, ETOVS 39/03). All efforts were made to comply with the standards set by Joubert, Bam and Cronjé (1999:62) regarding the use of correct and scientifically acceptable methods, thereby ensuring that feedback and reporting on the study were honest, frank and sensitive.

3.8 CONCLUDING REMARKS

In this chapter the study design, the methods as well as the process of the experiment were addressed. Theoretical aspects of the design were discussed, while the experimental instruments, the LPI, the pre- and the post-intervention test, as well as the questionnaire used as the method to collect data received attention. The reasons for using these particular methods were briefly touched on in Chapter 1 and a more complete discussion will follow in Chapter 5.

In Chapter 4, the results and findings of the study will be presented and the outcome of the educational interventions will receive special attention.

CHAPTER 4

RESULTS AND FINDINGS

4.1 INTRODUCTION

In this study a group of learners was subjected to an educational intervention. Learners were subjected to a formal test before and after the SIS. The test scores were subsequently used as a quantitative indicator to evaluate and compare the effectiveness of each intervention. In addition, a questionnaire was used to evaluate the experience of each learner as a subjective indicator of the separate interventions.

In this chapter results will be reported in three different sections: Learning preference inventory observations; pre- and post-test scores; and questionnaire results of perceived enhancers or constraints of academic achievement. Data will be presented by means of tables and figures.

4.2 STUDY GROUP

The study population consisted of 30 learners with a mean age of 20 years. The age of the learners ranged between 18 and 22 years. The group mainly consisted of females (n=25, 83% of the total group). The majority (56.7%, n=17) of the learners were White, 40% (n=12) Black, and 3.3% (n=1) Coloured. Reports on learners' home language (mother tongue) indicated that 53.3% (n=16) spoke Afrikaans, 6.7% (n=2) English, 30% (n=9) Sotho, and 10% (n=3) some other African language. The learners came from different geographic areas where they had completed their school education, namely 63.3% (n=19) from the Free

State, 16.7% (n=5) from the Northern Cape, and 20% (n=6) from other provinces. Forty-three percent (n=13) of the learners reported that they came from traditionally Black schools in and around Bloemfontein (see Table 4.1).

Table 4.1: Background information on the study population

	Number	% of total group
Gender		
Male	5	16.7
Female	25	83.3
Race		
Black	12	40.0
White	17	56.7
Coloured	1	3.3
Language		
Afrikaans	16	53.3
English	2	6.7
Sotho	9	30.0
Other	3	10.0
School		
White	17	56.7
Black	13	43.3
Distribution		
Free State	19	63.3
Northern Cape	5	16.7
Other	6	20.0

4.3 LEARNING PREFERENCE INVENTORY (LPI)

The next section illustrates the learners' learning preferences and the related ranking thereof. The LPI reflects preferences for learning situations and conditions. Contrasting scales are employed on three dimensions, namely abstract/concrete, learner-structured/facilitator-structured, and individual/interpersonal (also see Chapter 3, Figure 3.1). Results with regard to the ranking of learning preferences in the group of 30 learners are displayed in both Figure 4.1 and in Table 4.2.

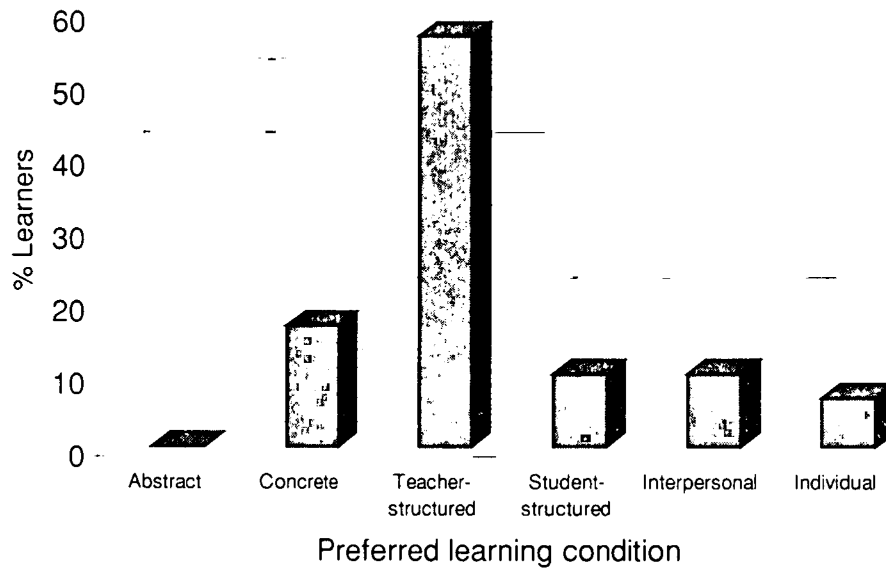


Figure 4.1: First learning preference

Fifty-six percent (n=17) of the learners reported that a teacher-structured approach in education was their first learning preference. The well-organised, facilitator-directed classes were their first choice as potential factor that improved learning (see Figure 4.1). This involves clear expectations, assignments and goals defined by the facilitator. All other learning preferences had 16.7% or less of the learners choosing that preference as first choice. Nearly half (43%, n=13) of the group indicated that their second preference was a concrete teaching approach, which entails the learning of tangible, specific, practical tasks and skills (see Table 4.2). The individual category was also chosen as a second preference by 36.6% (n=11) of the group. This involves a preference for learning or working alone, with an emphasis on self-reliance and tasks.

Abstract learning, the learner-structured category, as well as the interpersonal category featured throughout as the least preferred method of learning with median rankings of 4 or 4.5.

Table 4.2: Ranking of learning preferences

LPI ranking (n=30)	1st	2nd	3rd	4th	5th	6th	Median
Abstract (AB)	0	1	5	9	11	4	4.5
Concrete (CO)	5	13	9	3	0	0	2
Facilitator-structured (TS)	17	3	5	3	1	1	1
Learner-structured (ST)	3	2	6	5	8	6	4
Interpersonal (IP)	3	4	2	6	7	8	4.5
Individual (IN)	2	11	5	5	4	2	3

4.3.1 Association between SAT range and first learning preference

The majority of learners in the high SAT range (73,3%, n=11) preferred a teacher-structured approach while only 1 out of 8 learners (12,5%) in the low SAT range chose this approach as their first choice. In the average SAT range 5 out of 7 learners (71.4%) also made the teacher-structured approach their first choice. Three out of 8 learner (37.5%) in the low SAT range preferred an inter-personal approach to learning 4 (see Table 4.3).

Table 4.3: SAT range and first learning preference

		First learning preference					
SAT range (n=30)		TS	CO	ST	IP	IN	AB
0-49%	(n=8)	1	2	1	3	1	0
50-65%	(n=7)	5	1	1	0	0	0
66-100%	(n=15)	11	2	1	0	1	0

4.4 PRE-TEST SCORES

The mean of the pre-test scores for the group as a whole was 51.5%. Table 4.4 also shows that the mean pre-test score of the formal lecture group (mean=59.4%) was significantly higher compared to the self-activity group (mean=42.7%, p=0.007). There was no significant difference between the mean pre-test scores of the formal lecture group compared to the self-study group (median=51.7%, p=0.271). Therefore, the individual subgroup scores indicate that independent self-learning, i.e. self-activities, were significantly less effective than the formal lectures.

Table 4.4: Test scores before and after the intervention

	Pre-test scores				Post-intervention test scores		
	n	Mean%	Median %	Standard deviation %	Mean%	Median %	Standard deviation%
Group as a whole	30	51.5	51.5	15.2	70.4	71.5	9.6
Formal lectures	11	59.4	59.0	11.4	72.4	71.0	7.4
Self-activities	11	42.7	40.0	14.3	66.5	61.0	11.4
Self-study	8	52.6	51.7	14.4	72.9	71.5	10.3

4.5 POST-INTERVENTION TEST SCORES

Mean test scores for the group as a whole increased significantly (see Table 4.4) from the pre- to the post-intervention test (from 51.1 ± 15.2% to 70.4 ± 9.6%, $p < 0.001$). The post-test scores of both the self-study group (mean=72.9%) and the formal lecture group (mean=72.4%) tended to be higher when compared to the self-activity group (mean=66.5%). This difference was not statistically significant.

Improvements in test scores (see Table 4.5) from pre- to post-intervention were significant within all three learner groups (p=0.001 for the formal lecture group; p<0.001 for the self-activities group; and p=0.002 for the self-study group). The correlations between pre-intervention scores and changes from pre- to post-intervention test scores are provided in Table 4.6 and they support the above-mentioned findings.

Table 4.5: Descriptive statistics of the improvement in test scores

	n	Mean improvement%	Standard deviation	p-value*	95% CI of the difference
Group as a whole	30	18.9	11.3	<0.001	14.7; 23.1
Formal lectures	11	13.0	9.1	0.001	6.9; 19.1
Self-activities	11	23.8	11.2	<0.001	16.3; 31.3
Self-study	8	20.3	11.8	0.002	10.4; 30.1

*Paired Samples t-test

However, in order to assess the true effect of the intervention on the outcome of test scores in the different intervention groups, it is necessary to compare the magnitude of change or improvement in test scores between the respective learner groups. The improvement in pre- to post-intervention test scores for the self-activities group (23.8 ± 11.2%) is significantly higher compared to the improvement in the test scores of the formal lecture group (13.0 ± 9.1%). The improvement in pre- to post-intervention test scores for the self-study group tended to be higher compared to the formal group. However, this difference was not significant. The improvement in test scores within the self-activities group compared to the improvement of test scores within the self-study group also fell short of statistical significance.

Table 4.6: Correlations between changes from pre-intervention to post-intervention test scores

Study group	n	Correlation	Significance
Group as a whole	30	0.644	<0.001
Formal lecturers	11	0.611	0.046
Self-activities	11	0.639	0.034
Self-study	8	0.592	0.122

4.6 SCHOLASTIC APTITUDE TEST (SAT)

Existing official scholastic aptitude tests scores (SAT) were obtained as an indicator of the cognitive ability of learners (see Table 4.7). The group as a whole had a mean SAT score of 64.4% (standard deviation=26.0%). The self-study group had the highest mean SAT score (74.0 ± 20.6%). This high score is ascribed to the two learners with low SAT scores (27% and 34%) who had requested not to be part of the self-study group. These candidates were then included in the formal lecture and self-activities group.

Table 4.7: SAT scores

Study group	n	Mean%	Median%	Standard deviation%
Group as a whole	30	64.4	64.5	26.0
Formal lectures	11	63.3	63.0	28.4
Self-activities	11	58.5	55.0	27.3
Self-study	8	74.0	72.5	20.6

4.6.1 Associations between the SAT and the pre-test scores

Table 4.8 reflects the association between the SAT and the pre-test scores. The self-study group had the highest mean SAT score (74.0 ± 20.6%), while the mean pre-test scores (52.6 ± 14.4%) were second to that of the formal lecture group (59.4% ± 11.4). The formal lecture group had the second-highest mean SAT score (63.3 ± 28.4%), but obtained the highest mean pre-test scores (59.4 ± 11.4%). The self-activities group had the lowest SAT scores (58.5 ± 27.3%) and obtained the lowest mean pre-test score (mean=42.7% ± 14.3%).

Table 4.8: SAT and pre-test scores

	Formal lectures (n=11)		Self-activities (n=11)		Self-study (n=8)	
	SAT	**Pre-test**	**SAT**	**Pre-test**	**SAT**	**Pre-test**
Mean %	63.3	59.4	58.5	42.7	74.0	52.6
Standard deviation%	28.4	11.4	27.3	14.3	20.6	14.4
Median %	63.0	59.0	55.0	40.0	65.3	51.7

4.6.2 Associations between the SAT and the post-intervention test scores

Table 4.9 reflects the association between the SAT and the post-intervention test scores. The self-study group with the highest mean SAT scores (74.0 ± 20.6%) obtained the highest mean post-intervention test scores (72.9 ± 10.3%). The formal lecture group with the second-highest mean SAT scores (63.3 ± 28.4%) obtained the second-highest mean post -intervention test scores (72.4 ± 7.4%). The self-activities group with the lowest mean SAT scores (58.5 ± 27.3%) obtained the lowest mean post-intervention test scores (66.5 ± 11.4%).

Table 4.9: SAT and post-intervention test scores

	Formal lectures (n=11)		Self-activities (n=11)		Self-study (n=8)	
	SAT	Post-test	SAT	Post-test	SAT	Post-tes
Mean %	63.3	72.4	58.5	66.5	74.0	72.9
Standard deviation%	28.4	7.4	27.3	11.4	20.6	10.3
Median %	63.0	71.0	55.0	61.0	65.3	71.5

The mean SAT, pre-test and post-intervention test scores are displayed in Figure 4.2.

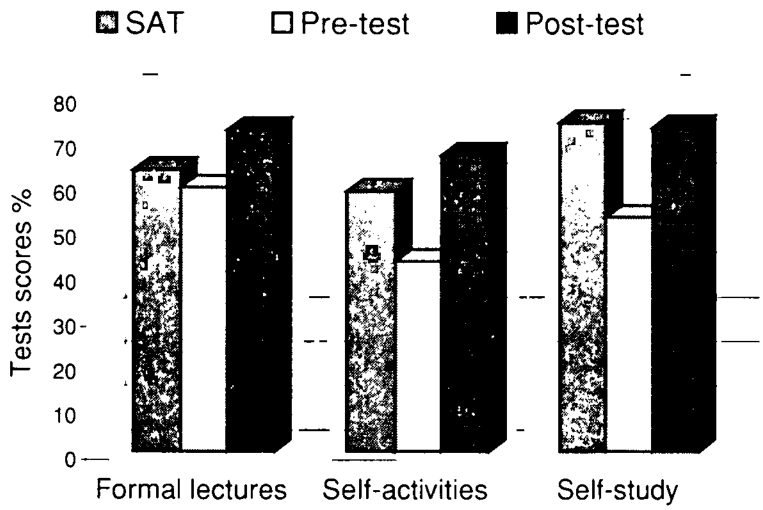


Figure 4.2: SAT, pre-test and post-intervention test scores

4.6.3 Correlations between SAT, average test scores, pre- and post-intervention test scores and improvement from pre- to post-intervention test scores

The strength of correlation between the improvement in pre- to post-intervention test scores SAT, average test scores (ATS) and pre- and post-intervention test scores is reported in Table 4.10.

A significant negative correlation was measured between SAT and the improvement in test scores from pre- to post-intervention in the formal lecture group. Furthermore, the negative correlation between the average test scores and the improvement in test scores of the group as a whole and the formal lecture group was significant. A significant negative correlation was also measured between the pre-intervention test scores and the mean improvement in test scores of all the study groups.

Table 4.10: Correlations between SAT, ATS, pre- and post-intervention test scores and improvement from pre- to post-intervention test scores

Variable		Improvement in test scores			
		Group as a whole	Formal lectures	Self-activities	Self-study
SAT	r#	-0.274	-0.624*	-0.109	-0.153
	Significance	0.142	0.040	0.749	0.717
ATS	r	-0.381*	-0.692*	-0.146	-0.452
	Significance	0.038	0.018	0.669	0.261
Pre-test	r	-0.743**	-0.795**	-0.624*	-0.707*
	Significance	0.000	0.006	0.040	0.050
Post-test	r	0.033	0.043	0.203	0.152
	Significance	0.863	0.899	0.550	0.720

Pearson correlation
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

4.6.4 Association between mean % increase in test scores and SAT range

Classification of SAT scores into three categories based on low (0 to 49%), average (50 to 65%) and high academic aptitude (66 to 100%) was used to compare the association between mean percentage increase in test scores and SAT range. The mean increase in test scores is illustrated in Table 4.11 and in Figure 4.3. In the group as a whole learners in the low and average academic competency group showed a higher increase in test scores (mean=16.3% and 21.5%) than the higher competency group (mean=11%). The formal lecture group showed the highest increase in test scores (mean=23.7%) in the low SAT range, while the average SAT range in the self-activities and self-study groups showed the highest increase (mean=34.5% and 23.0%) in test scores. The high SAT range showed the least increase in test scores in the group as a whole (mean=11.0%) and the formal lecture group (mean=9.2%). The numbers in the subgroups are small, however, and the statistical value is therefore limited.

Table 4.11: Association between mean increase in test scores and SAT range

	Mean increase from pre- to post-test score in%			
SAT range in%	**Group as a whole (n=30)**	**Formal lectures (n=11)**	**Self-activities (n=11)**	**Self-study (n=8)**
0-49	16.3 (n=8)	23.7 (n=3)	21.5 (n=4)	19.0 (n=1)
50-65	21.5 (n=7)	8.7 (n=3)	34.5 (n=2)	23.0 (n=2)
66-100	11.0 (n=15)	9.2 (n=5)	21.4 (n=5)	19.4 (n=5)

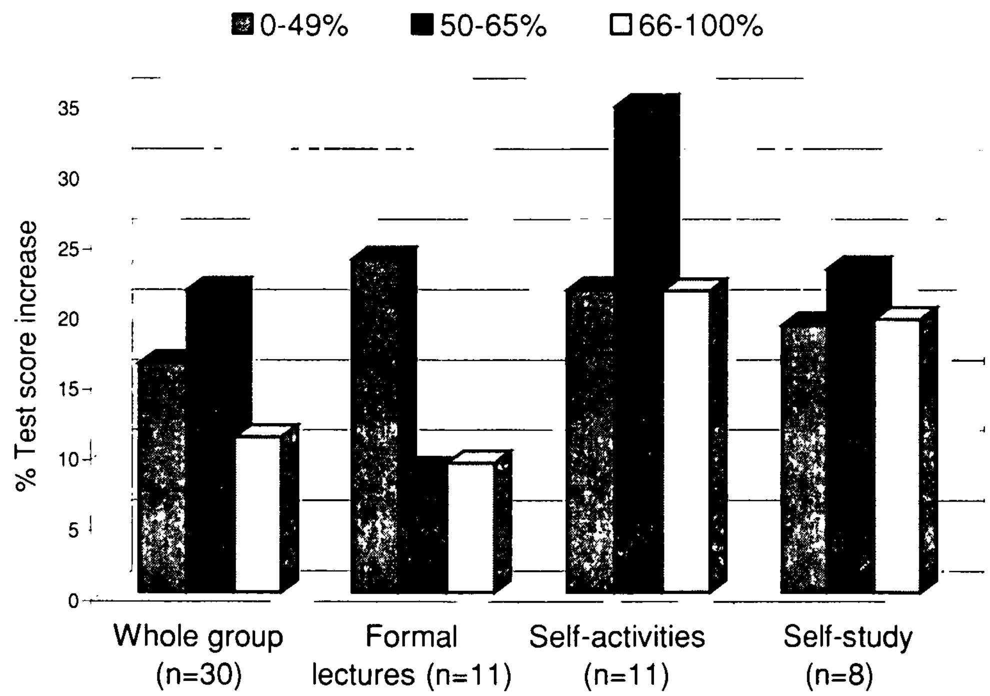


Figure 4.3: Association between mean increase in test scores and SAT range

4.7 QUESTIONNAIRE

The learners reflected on their perception of the effectiveness of the structured interactive sessions (the intervention) in the questionnaire. The questionnaire contained a biographical section, eliciting responses regarding factors such as gender, age, home language (mother tongue), and demographics (see paragraph 4.1). For the remainder of the questionnaire learners had to indicate the extent to which the respective teaching approaches influenced their learning.

Information obtained from the questionnaires indicated that the enhancement of learning was mostly due to the practical nature of, and active participation in, facilitator-structured activities. The questionnaire distributed at the end of the study required the learners to indicate their agreement with a series of statements on a "Yes" or "No" basis. The statements relevant to the teaching method; the role of the lecturer; study methods; general comments regarding their experience with the intervention; and the responses of the 30 learners will subsequently be discussed.

Results from the questionnaire indicate factors that affect learning in one way or another. Factors that were reported to influence learning positively by means of improving academic performance to a large extent are provided in the following paragraphs.

4.7.1 Teaching methods which improved marks

Learners were asked to choose the teaching method that would improve their marks (see Table 4.12). The majority, 93.3% (n=28) and 73.3% (n=22) of the learners reported that lecture interactive activities in class and individual assignments respectively were the prominent factors that improved their marks. Half of the learners, 53% (n=16), mentioned that the use of only formal lectures had influenced their academic performance.

More than 60% (n=18) of the learners reported that group activities, independent self-study and group assignments in class could improve their marks, while 60% (n=18) mentioned that independent self-study was not a teaching method that would improve their performance.

Table 4.12: Teaching method which improves learning experience

Teaching method that will improve their marks	Learners (n=30)					
	Yes (n)	%	No (n)	%	Unsure	%
Formal lectures	16	53.3	12	40.0	2	6.7
Independent self-study	10	33.3	18	60.0	2	6.7
Lecture interactive activities in class	28	93.3	1	3.3	1	3.3
Group activities	18	60.0	10	33.3	2	6.7
Independent individual activities	19	63.3	9	30.0	2	6.7
Fellow-learner presentations	12	40.0	16	53.3	2	6.7
Individual assignments	22	73.3	7	23.3	1	3.3
Group assignments in class	19	63.3	8	26.7	3	10

4.7.2 The role of the lecturer

In the questionnaire items that examined the importance of lecturer input as constituent to increased marks 96.7% (n=29) and 100% (n=30) of the learners responded by pointing out that the lecturer's role is to provide information and knowledge and notes respectively and also to promote interaction during formal lectures (96.7%, n=29). Sixty percent (n=18) of the learners reported that their marks would have increased if the lecturer had guided and structured self-study. The majority of the learners, 80% (n=24), mentioned their preference for lecturer involvement and all the learners indicated that they had learned more when the lecturer was active in the learning process (see Table 4.13).

Table 4.13: The role of the lecturer

Lecturer importance to increase marks	Learners (n=30)					
	Yes	%	No	%	Unsure	%
Providing information and knowledge?	29	96.7	1	3.3	0	0
Supplying notes?	30	100.0	0	0.0	0	0
To guide and structure self-study?	18	60.0	10	33.3	2	6.7
To promote interaction during formal lectures?	29	96.7	1	3.3	0	0
The lecture participation influences your marks?	24	80.0	5	16.7	1	3.3
Do you prefer the lecturer to be only a facilitator (not active)?	1	3.3	29	96.7	0	0
Do you learn more if the lecturer is active in the learning process?	30	100.0	0	0.0	0	0

4.7.3 Preferences for study methods

The learners reported that they used the following methods when studying: The whole group reported that they used lecturers' notes, while 83.3% (n=25) read through information a few times. The majority of the learners (76.7%, n=23) made summaries and more than 60% (63.3%, n=19) studied only for tests or exams. Studying in groups was perceived by only 26.7% (n=8) as a preferred method of studying (see Table 4.14).

Table 4.14: Preferred methods of study

Study methods	Learners (n=30)					
	Yes	**%**	**No**	**%**	**Unsure**	**%**
Just read through information in your textbook once?	3	10.0	26	86.7	1	3.3
Read through information in your textbook a few times?	25	83.3	5	6.7	0	0
Make summaries?	23	76.7	7	23.3	0	0
Draw mind maps of important information?	12	40.0	18	60.0	0	0
Prefer to use just lecturers' notes?	9	30.0	20	66.7	1	3.3
Use lecturers' notes as well as other methods?	30	100.0	0	0.0	0	0
Like to study in groups?	8	26.7	22	73.3	0	0
Study directly after lectures?	10	33.3	20	66.7	0	0
Study only for tests or exams?	19	63.3	11	36.7	0	0

4.7.4 Preference for assessment methods

Formal examinations and tests were the learners' (96.7%, n=29) preferred method of assessment, followed by assessment through assignments (80%, n=24) and OSCEs (73.3%, n=22). More than 60% (63.3%, n=19) of the learners preferred self-demonstrations and self-presentations as preferred method of assessment. Orals and integrated tests (16.7%, n=5) were least preferred (see Table 4.15).

Table 4.15: Preferred methods of assessment

Assessment methods	Learners (n=30)					
	Yes	%	No	%	Unsure	%
Formal examinations	29	96.7	0	0.0	1	3.3
Formal tests	29	96.7	1	3.3	0	0
Integrated tests	5	16.7	25	83.3	0	0
Practical exams at the TFS	19	63.3	11	36.7	0	0
Practical exams in Practice	11	36.7	19	63.3	0	0
Assessment through assignments	24	80.0	6	20.0	0	0
OSCEs	22	73.3	6	20.0	2	6.7
Orals	5	16.7	25	83.3	0	0
Fellow-learner assessment	10	33.3	20	66.7	0	0
Through self-demonstrations	19	63.3	11	36.7	0	0
Through self-presentations	19	63.3	11	36.7	0	0

4.7.5 General factors associated with learning

A total of 73.3% (n=22) of the group reported that outside factors existed that influenced their learning performance (see Table 4.16). The feedback of the learners on the worth of interactive activities in class was seen as a positive and an encouraging factor to improve learning. Eighty-three percent (n=25) of the learners indicated that they learned more from reflective activities in class than just formal lectures. The group as a whole reported that interactive lectures promoted their insight and understanding of a subject. In addition 83.3% (n=25) of the learners pointed out that self-activities improved their learning experience. In contrast, two- thirds of the learners reported negative responses to independent self-study.

Table 4.16: General factors associated with learning

	Learners (n=30)					
	Yes	%	No	%	Un-sure	%
I am satisfied with my career choice	28	93.3	1	3.3	1	3.3
Own a relevant Merrill or Bontrager textbook	27	90.0	3	10.0	0	0
Use the library to obtain additional information	17	56.7	13	43.3	0	0
Use the library to obtain just the necessary information	17	56.7	13	43.3	0	0
Outside factors exist that influence my learning	22	73.3	7	23.3	1	3.3
I am satisfied with my marks	9	30.0	21	70.0	0	0
The lecturer play an important role in my learning process	29	96.7	0	0.0	1	0
The Year organiser helps me to plan my learning	20	66.7	9	30.0	1	0
The learning guide is an important source of knowledge	30	100	0	0.0	0	0
I prepare for lectures	11	36.7	17	56.7	2	0
I often postpone learning	15	50.0	15	50.0	0	0
I prefer independent self-study to interactive lectures	11	36.7	19	63.3	0	0
I learn more from reflective activities in class than from formal lectures	25	83.3	5	16.7	0	0
Interactive lectures promote my understanding of the subject	30	100	0	0.0	0	0
I like to take part in class discussions	23	76.7	7	23.3	0	0
I feel isolated during independent self-study	10	33.3	20	66.7	0	0
Activities improve my learning experience	25	83.3	5	16.7	0	0
The lecturer must be a role model in the learning	30	100	0	0.0	0	0

4.7.6 Experience with teaching methods

The learners were asked to reflect on their experiences as far as the different teaching methods were concerned. In these specific items learners were requested to rank the importance of a specific teaching method as a possible factor that could improve their marks, using (1) as the most important; (2) as the second-most important; etc. Forty percent (n=12) of the learners reported lecturer demonstrations as the most important factor that could improve their marks (see Table 4.17). All other teaching methods had 26.7% (n=8) or less of the learners choosing them as possible factors that influenced their marks as a first choice. None saw peer presentations as a factor that could improve their marks. Contact sessions with a variety of activities and lecturer demonstrations were the teaching methods most positively experienced with a median ranking of 2.

Table 4.17: Experience with teaching methods

Teaching method that improves marks	**Learners (n=30)**						
Ranking	**1st**	**2nd**	**3rd**	**4th**	**5th**	**6th**	**Median**
Independent self-study	4	3	5	7	4	7	4
Formal lectures without interaction	8	6	6	5	2	3	3
Contact sessions with a variety of activities	8	9	3	5	4	1	2
Group discussions	2	4	10	2	6	5	3
Peer (fellow-learners') presentations	0	2	4	9	4	11	4.5
Lecturer demonstrations	12	10	4	3	0	1	2

4.7.7 Personal factors influencing learning

Personal factors influencing learners' learning were reported on as follows (see Table 4.18): According to 56.7% (n=17) of the learners the cost of textbooks was not a factor hindering learning. Insufficient study-time was reported by 83.3% (n=25) of the learners; poor time management by 63.3% (n=19); poor concentration by 60% (n=18) and outside factors by 50% (n=15) as factors that influenced their learning. Seventy percent (n=21) experienced study stress, while 50% (n=15) experienced work-related and personal stress. Financial burdens were an issue in learning reported by 63.3% (n=19) of the learners and 10% (n=3) indicated that other factors existed that influenced their learning.

Table 4.18: Personal factors influencing learning

	Learners (n=30)					
Personal factors	**Yes**	**%**	**No**	**%**	**Unsure**	**%**
Cost of textbooks	13	43.3	17	56.7	0	0
Insufficient study time	25	83.3	4	13.3	1	3.3
Poor time management	19	63.3	11	36.7	0	0
Poor concentration	18	60.0	12	40.0	0	0
Outside factors	15	50.0	15	50.0	0	0
Experiencing study stress	21	70.0	9	30.0	0	0
Experiencing work stress	15	50.0	15	50.0	0	0
Experiencing personal stress	15	50.0	15	50.0	0	0
Financial burdens	11	36.7	19	63.3	0	0
Others	3	10.0	27	90.0	0	0

4.8 SUMMARY

The LPI results indicated that teacher-structured and concrete approaches to teaching were preferred by most of the learners, while abstract learning featured throughout as the least preferred method of learning. The post-intervention test scores for the group as a whole and within all three learner groups increased significantly from the pre- to the post-intervention test. The improvement in pre- to post-intervention test scores for the self-activities group is significantly higher compared to the improvement in the test scores of the formal lecture group.

Reports on the teaching method that will improve academic performance "lecture interactive activities" in class were seen as the most dominant factor that influenced the learners' marks. The whole group saw the role of the lecturer as an important factor to improve marks if the lecturer actively took part in the learning process and guided and structured self-study. The study method that the learners preferred was to use lecture notes to study. Independent self-study, group discussions and peer presentations were reported to be less important in playing a role in academic performance. Formal examinations and tests were preferred by the learners as methods of assessment. An interactive approach to education was associated with improved test scores with a high acceptability of interactive learning by the radiography learners.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

5.1 INTRODUCTION

In view of the fact that increased diversity in higher education occurs, it has become critical to address the needs of non-traditional learners, especially the low-achievers (Henderson in Ruban *et al.* 2003:270). In an attempt to address this issue and answer the question "How can learners be encouraged to become more effective learners?", the impact of an interactive education strategy on radiography education was explored. The above-mentioned question forms the essence of this endeavour and the answer was searched for in the literature as well as in the outcome of this study. This chapter is a discussion of the main findings from both the literature and the research done. Salient points will be argued and connections between the reviewed literature and the results of the present study will be presented. Specific recommendations regarding the potential use of the educational strategy, possibilities for further research and the limitations of the study will receive attention.

As mentioned in Chapters 1 and 2, academic enablers (non-academic skills which contribute to academic success) which influence academic achievement include the entirety of intrinsic motivation, goal orientations, social skills, as well as self-efficacy, to name but a few (Linnenbrink & Pintrich 2002:313). Owing to the complex nature of academic competence and the time constraint of academic schedules, the influence which facilitators could have on the whole continuum of learners' academic achievement is limited. However, considering the relevant literature which suggests that instructional efforts could make a difference to learners' academic competence, interactive instructions were considered to promote academic achievement and were therefore investigated. The concerns with regard to how valid and appropriate the findings are in addressing the lack of academic success in the radiography programme, will receive attention in the next paragraph.

5.2 VALIDITY OF THE STUDY

The remark "Educational research has recently been described as unhelpful in answering real life questions", made by Jolly (2001:920), addresses not only the internal and external validity of this investigation, but also questions the value or significance thereof in the intended programme. Internal validity is defined by Jolly (2001:920) as the capacity to be able to state explicitly that the effects demonstrated within the study are ascribed to the manipulations made by the researcher and not existing external factors, while the external validity is the "generalisability" of the results of the educational research. To exclude these limitations, the current experimental conditions, the intervention, as well as the pre-post test control group approach to the study were therefore designed specifically to represent teaching and learning patterns that mimic everyday radiography education. This allowed the current investigator to extrapolate findings to real life conditions and to see interactive instruction as an effective education approach to improve academic success. The study methodology that follows explains the approach to the study and interprets the results in terms of the literature.

5.3 STUDY METHODOLOGY

Research in medical education is no longer in its early stages and, to a large extent, it has added to the understanding of the learning process

(Norman 2002:1562). The study of the relevant literature covered in Chapter 2 helped the researcher to develop an insight into factors associated with learning and the literature further assisted in structuring the study design described in Chapter 3. Kumar (2003:24), who states that learners are in a position to judge instructional effectiveness, further supports the course and outcome of the current experiment.

The approach to the present study was based on the remarks of Kumar (2003:24) that the performance in examinations is the traditional test for evaluating success in education. Although the author propagated an objective measure for education effectiveness, it was not used in this investigation. To validate the findings on interactive lecturing techniques, only a questionnaire as a measure to assess learners' perception of the approach was used. Kumar argued that performance was not used to measure the effectiveness of the strategy because learners had different abilities. To exclude performance as an objective measure on the grounds of learners' diversity seemed irrelevant. The reasons for the specific methods that were used during the investigation will be explained in the following paragraphs and are supported by the literature.

5.3.1 The Learning Preference Inventory (LPI)

Anderson (2001:1) urges educators to realise the importance of learning styles and to relate them to the diverse needs of learners. The author also asks if instructional methods should be adjusted to accommodate learning styles. The present study shows the importance thereof. The structured interactive sessions included a combination of educational methods. It could thus be argued that the variety in instruction used during the intervention provided a preferred style of learning to the learners and, as a result, led to the improved post-intervention test scores of the diverse learners.

The outcome of the LPI as reported on in Chapter 4 is of notable value, since the results thereof, the pre-test and the post intervention test scores, as well as the questionnaire shared the same teacher-structured interactive dominance. The results suggest that interventions aimed at improving academic achievement need to address learners' learning styles. Ferguson *et al.* (2002:955) capture the importance of learning styles. They state: "Learning styles cover both motivation for learning and the processes by which the student approaches the task of learning." The authors also suggest that learning styles can be changed and that educators should teach learners to use the most effective style.

It is thus recommended that knowledge of the learning style preferences of learners, along with their implications for academic performance, may give facilitators insight into teaching and learning approaches and thus allow them to modify non-productive teaching methods and strengthen beneficial ones.

5.3.2 Choice of content

The choice of content for the two themes used during the investigation, i.e. the cranial and the facial bones, was carefully considered. The two themes were different in content, but similar with regard to the quantity of information; the level of difficulty; and the level of knowledge needed to write the pre- and the post-intervention tests. The parallel content allowed the comparisons which were made during the analysis of the data.

5.3.3 The division of groups

Since the aim of the OBET approach is self-directed and independent learning the learners were divided into the formal lecture, self-activities, and self-study groups. This division allowed the comparison between learner-centred education and the more traditional approach to education, which is the formal lecture. Learners' active involvement in the learning process is seen by the NQF (2000) as a way to achieve academic success, therefore the SIS intervention group allowed active learner involvement and encourages independent learning.

5.3.4 The intervention

The researcher's preferences for methods of instruction during the structured interactive sessions were counteracted in using the results from the LPI to gather additional information to identify possible learning style differences that might influence academic performance among learners. In an attempt to improve the quality of educational research, Murray (2002:111) claims that experimental interventions are complex and it is often difficult to identify which component of the intervention is responsible for which result. It is recognised that, since the interactive education intervention explored in the current investigation was as complex as indicated, no attempt was made to suggest any specific component in the education strategy that led to the positive outcome observed.

Treloar, McCall, Rolfe, Pearson, Garvey, & Heathcote (2000:708) propose that interventions aimed at enhancing academic achievement face the challenge of providing optimal learning environments for learners from diverse backgrounds. This investigation explored interactive education as a potential strategy in reaching the ideal learning environment, since the target group consisted of learners from diverse backgrounds. It is therefore suggested that the multidimensional approach of the structured interactive sessions addressed the variety of learning needs of the learners and resulted in test score improvement. Kumar (2003:25), who claims that stimulation through interactive education and motivation to learn is more important for retention than intelligence, confirms the argument. Vaughn *et al.* (2001:39) also used a combination of various teaching approaches to motivate learners with different learning styles to enhance and strengthen the learning process. The authors found the multidimensional approach a useful teaching-learning model.

It is understood that interactive education strategies rely on an understanding of the theory of teaching, as well as knowledge of current research on the effectiveness of instruction strategies - matters that were searched for in the literature (see Chapter 1). The pedagogic shift from teacher to learner is widely propagated in educational literature (see Chapters 1 and 2). However, no clear distinctions were made in the literature as to exactly which strategy would be ideal to make the shift.

Learner-centred or self-directed strategies, which have been developed, include problem-based learning; resource-based learning; task-based learning; reflective learning; and autonomous learning. From the perspectives gained in the present study, it is suggested that a combination rather than only one strategy be used to optimise learning. Vaughn *et al.* (2001:43) explored a strategy in which their aim was to address learning style preferences. The authors state that the success of such a strategy depends on the educators' sensitivity to learners' individual learning style preferences; their ability to assist learners in identifying their learning strengths and weaknesses; and to use a variety of teaching methods to help learners to reach their academic goals. A variety of opportunities should therefore be available to the learners to address their individual differences, as noted in paragraph 5.3.1. In other words, a mixed approach could best benefit the diverse learner population. A learning guide is seen as a potential tool that structures this combined educational approach. A brief discussion of the use and value thereof follows.

5.3.5 The learning guide

The learners in the current study reported that the learning guide helped them to plan and structure their learning and they also see it as an important source of knowledge. The importance of the learning guide is put forward by Spencer and Jordan (1999:1282). They see the learning guide as the main tool by which facilitators could support self-directed learning and, at the same time, ensure active involvement of learners. A point of view shared by the current researcher is that the learning guide as a structured medium facilitates learning. It is designed to direct learners through a series of learning activities to achieve specified outcomes (Harden *et al.* 1999:248). The learning guide is therefore seen as an important education strategy to structure both the process of learning and the approach to teaching, since it forces both the learner and the facilitator to stay active in the teaching-learning process. The shift from a teacher-centred to a learner-centred approach to education requires that learners become more accountable for their own learning (TFS 2003:1). Since the learners in the radiography programme needed direction and support with this approach, the learner guide had an important function to fulfil (Harden *et al.* 1999:249).

5.3.6 The pre- and the post-intervention tests

Objective test questions and answers in the pre- and the post-intervention tests ruled out variations associated with the observer. The questions did, however, not address the higher cognitive levels of analysis, synthesis and evaluation, which made the pre-post test evaluations more objective. Although objectivity was reached, the content lends itself to the assessment of knowledge retention only.

5.3.7 The questionnaire

It was clear that the majority of the learners had gained more learning experience in this interactive education approach than through traditional classroom teaching. Results obtained from the questionnaire showed that individuals were receptive to this method of instruction and found these interactions to be good at stimulating their learning interest.

As a measuring tool, the questionnaire served its purpose in identifying areas which the learners found to be enhancers or constraints to learning. The outcome thereof, however, only allowed for quantitative and not qualitative results. Including open-ended questions or interviews in the measure could have improved the validity of the questionnaire as a research tool. The questionnaire items also forced the learners to focus only on those factors included in the questionnaire as potential enablers or constraints to learning.

5.4 LIMITATIONS OF THE STUDY

The investigation was largely successful in achieving its overall goal and supporting the goal of the academic institution, which is to promote and enhance educational (teaching and learning) success and development with a view to maintaining and promoting the quality of education and training. The intervention, using quantitative methods, helped in the collection of useful information on how teaching and learning could be improved. However, a number of limitations must be considered in interpreting the results of the study. First, the study was restricted to performance in a controlled test situation. Second, the small sample size - which was a convenience sample - and the fact that learners from one programme were used, limited the claim that these findings could be representative of other settings. A larger and more diverse sample would have provided a more widely applicable measurement for academic improvement. Third, the results reported here are based on a single intervention. It is possible that a different approach covering different content would have yielded different results.

The pre- and the post-intervention test measurement of gain in knowledge may be acceptable for a targeted intervention, but when the aim of an educational intervention is to assess attitude, behaviour or the acquisition of skills, this approach is too simplistic (see paragraph 5.3.6). The positive outcome of the investigation is also only relevant on the level of the intervention and extensive application of the interactive strategy alone could prove whether the intervention had the potential to benefit the radiography learning programme as such.

A further limitation to the current empirical study regarding the impact of an interactive education strategy is that the investigation primarily explored the contribution of only interactive education on learning, rather than combinations of factors enhancing or hindering academic achievement. Murray (2002:111) emphasises that, in order to evaluate complex interventions in medical education, both quantitative and qualitative approaches are essential. Although the current investigation made use of both a pre-post test model and a questionnaire to evaluate improvement and perception of the intervention, the questionnaire did not allow for qualitative results mentioned in paragraph 5.3.7. This is seen as a limiting factor, since it resulted in both the measurements (test results and perceptions) being quantitative. It is therefore recommended that future studies in this area should allow for the inclusion of qualitative measures to improve the validity of research and uphold the value thereof. In future, a combination of methods, including both open-ended questions and interviews, would offer a better approach.

The likelihood of a "Hawthorne effect" is high. Since the learners knew that the test scores were used to make a comparison, they might have put in more effort to perform. Despite these limitations, the information gained from the study suggests how learners learn and what they perceive as possible factors that can improve their marks. Wilkes and Bligh (1999: 1271) claim that, if one knows how learners learn, it is as meaningful as what they learn and that realising how they learn can contribute much to enhancing what they learn. Learning being the core of the current investigation was thus elucidated.

Over and above the limitations mentioned, the results of this investigation yield a number of interesting findings of relevance to radiography educators: First, learners are still dependent on facilitator guidance and expect facilitators to structure the learning process. Second, since the learners who had participated in this investigation were from diverse settings, the mixed approach of the structured interactive sessions accommodated the diversity in learning styles in some way or another.

5.5 FINDINGS

Interactive education will neither eliminate the poor throughput rates experienced in radiography education, nor will it be perfect, but this method of teaching has a number of apparent strengths. The traditional format of one-to-one teaching is retained, while the facilitator has the opportunity to participate actively in defining activities and questions. From the available evidence, the importance thereof was explicit in the findings of the learners' perception and expectation demonstrated in the results from the questionnaire. Of the 30 learners, 93.3% (n=28) indicated that the "Lecture interactive activities in class" was their preferred method of teaching. The role of the lecturer was seen as the promoter of interaction during lectures and 24 out of 30 learners (80.0%) stated that active lecture participation positively influenced their marks (see lecture interactive activities, to promote interaction during formal lectures and lecture participation influence marks, in Chapter 4, paragraphs 4.7.1 and 4.7.2). Radiography learners are used to a rigid didactic teaching structure and it is likely that their lack of willingness to take part independently in self-study and self-activities reflected unfamiliarity and anxiety as far as this teaching approach was concerned.

That the lecture has a place in radiography education is certain, since learners in radiography are still dependent on lecturer guidance, as is evident from the LPI and the questionnaire results. As a result of previous reports from the literature, the future of the traditional lecture was a matter of concern. Morrison (2001:7) states that, in the days when university classes contained highly selected learners, the traditional lecture appeared to be successful, but at present, with a more diversified learner population, many learners seem unable to cope. Minton (1998:399) supports this notion by indicating that formal lectures were effective in an era when fewer learners were selected; where the learners were of a more homogeneous nature; and small classes ensured adequate contact between learners and their lecturers. It was thus expected that the traditional didactic lecture in the current investigation would come forth as being perceived as the least effective teaching/learning tool when compared with other methods used in the study.

However, what is noteworthy, is that the formal lecture is popular and was perceived as being effective. The majority of the learners indicated that the tradition of the lecture was acceptable and it was seen as an effective learning mechanism if the learner was actively engaged. These responses were consistent with the frequent verbal comments offered by the learners throughout the study, expressing uncertainty about the self-activities and independent self-study. The feeling of uncertainty was generally associated with a sense of doubt that they would not adequately interpret the learning content and they missed the reinforcement of the lecturer being active in the teaching process. Thus the learners were more comfortable with the traditional lecture format than with the independent self-activities and self-study as teaching methods to increase academic performance, but lecture involvement in interactive class activities was their method of choice. The variations on the lecture format are merited. Butler (1992:15) supports this view by suggesting that the "mixed" lecture can be stimulating, inspiring and an effective learning instrument.

The results of the three measures, i.e. the LPI, the questionnaire, and the pre-post test model used in the intervention, shared a prevalent important component, namely the significant role of the facilitator. The LPI results demonstrated dominance in preference for a teacher-structured learning environment (see Chapter 4, paragraph 4.3). The aforementioned fact is confirmed by the distribution of test scores in the pre-test indicating that the groups with no facilitator guidance had lower test marks than the group who had received formal lectures (see Chapter 4, paragraph 4.4). The learners' perception and experiences verified preference for facilitator guided activities in class (see Chapter 4, paragraphs 4.7.1 and 4.7.2). This phenomenon affirms the findings of Treloar *et al.* (2000:708) in their research on the factors affecting progress in medical schools. They claim that problem-based learning, which promotes independent learning through group and self-directed learning, may be unsuited for diverse learners, because they rely on verbal interaction and group interactive learning. These learners reported that a lack of guidance resulted in anxiety, inefficiency in learning, and gaps in knowledge.

The previous comment emphasises the need of learners that facilitators should be an integral part of the learning process and that a shift from lecturer to learner as proclaimed by the literature is not a paradigm easily reached. This observation could explain the learners' incapability or unwillingness to act as independent learners in the radiography learning programme stated in Chapter 1.

5.6 RECOMMENDATIONS

The present study is an exploratory, quantitative investigation that does not claim to be representative of other settings. The intention of the study was to explore an interactive education strategy to enhance learning and therefore academic achievement. The process of learning is complex - as mentioned in Chapter 2 - with many variables, for example academic ability, self-regulation, self-efficacy, motivation approaches to learning, study skills and learning style preference, to mention but a few. Therefore, the findings cannot be made applicable to other settings. Studies involving larger cohorts of learners from both experimental and control groups to assess the impact of an interactive intervention on learners' learning should be pursued to substantiate the findings of this study. However, extended studies could rouse ethical concerns on offering all learners equal access to a potentially beneficial educational strategy.

The study was limited in that it relied only on learners' feedback in the form of tests and a questionnaire. Further research could test the effectiveness of the intervention (SIS) in improving learners' academic performance, relying on a direct analysis of the quality of learning using a pre- and a post-intervention test, randomised control group design. However, issues of treatment conformity and ethical concerns about providing all learners equal access to a potentially beneficial educational approach would complicate such a study.

Learners could, in addition, be asked to individually make a list of criteria (or a model) of factors that improve learning before and after the intervention to determine whether they were able to identify a wider range (or more refined set) of criteria as a result of the intervention. This approach would also allow for closer inspection of the way that learners think about interactive learning and, could therefore simultaneously enhance the educational value of the intervention while gathering research data. Finally, learners' ratings of the value of the educational strategy could be obtained through a brief interview which could add a qualitative outcome to the study and, as a result, improve the validity of the study.

Possible areas for future research include replicating these results to verify the validity and investigations on interventions for learners who fail to succeed academically. The researcher, however, suggests that the choice of teaching must continue to be based on the union between learning unit goals and learners' needs.

5.7 IMPLICATIONS OF THE RESEARCH STUDY

The results from this study will assist the institution to modify the learning environment to foster desirable approaches to learning that will enhance academic achievement. Interactive learning may not be ideal as the only instrument to enhance academic performance, yet it could still be a valuable educational tool when used in combination with other teaching techniques. A further long-term effect of this interactive approach to teaching is that learner radiographers are guided towards autonomous learning. Autonomous learning is the first step to lifelong learning, a responsibility that heavily depends on the practising radiographers' responsibility to take part in and take advantage of mandatory continuous professional development (CPD).

It is realised that much thought is still needed as to which of the many learner-centred approaches should be adopted; how they can be implemented in different settings; and what resources and staff are needed to support the strategy. The main implication of accepting structured interactive sessions as a general mechanism for improving learners' learning is the increase in preparation time. Since each learner receives three to six sheets of paper for the learning guide containing the interactive activities for each session, the interactive educational approach also has higher cost implications than the formal lecture approach.

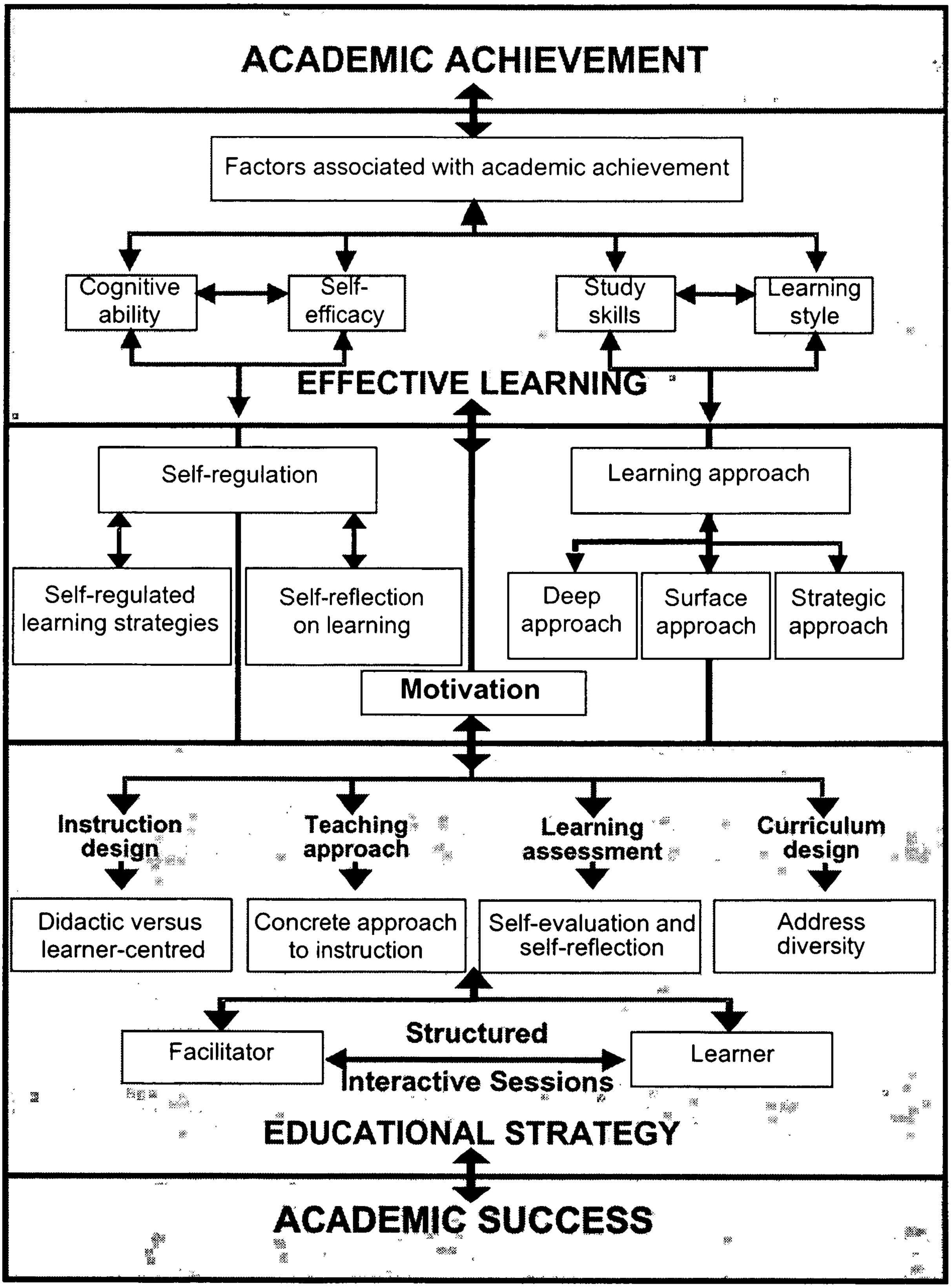
This study offers a preliminary description of and reflection on an educational strategy conducted with learners to enhance academic performance. This activity suggests one way to "scaffold" learners' ability to manage their own learning, a vital aspect of learner-centred learning. Further research could focus on other educational methods of enhancing learning. Such descriptive reports, even at preliminary stages, may be useful to facilitators and others who work with diverse learner populations.

5.8 SUMMATIVE PERSPECTIVE OF THE RESEARCH STUDY

The research that was undertaken mainly concentrated on improving academic achievement. The factors associated with academic achievement received attention and the predictive power and/or value of these factors with regard to academic success were derived from a comprehensive study of the literature. The interconnection between these factors also became clear, since authors - as mentioned in Chapters 1 and 2 - who had investigated specific causes for underachievement, identified this interdependence. Motivation is seen as the most dominant factor in all of the factors described, since it is perceived as more important than cognitive ability to improve retention of knowledge. In addition, motivated learners tend to be more self-efficient and self-regulated; they have a deep and strategic approach to learning; and also use more effective study skills while motivation furthermore plays a significant role in the use of effective learning and study strategies.

An optimal educational strategy being the core of the study therefore should first of all address motivation. Structured interactive sessions (SIS), which imply that both the facilitator and the learner are active in the learning process, construct a platform to motivate learners. This educational approach also scaffolds the process of effective learning through a teacher-structured instruction design and a concrete approach to teaching. Additionally, learning assessment through self-evaluation and self-reflection is also a potential enhancer of motivation. Allowing integration in the curriculum and, finally, accommodating learner diversity in the curriculum design furthermore sets the stage for academic success (see Figure 5.1).

Figure: 5.1: Summative perspective of the research study



The aforementioned findings therefore propose that an educational intervention, designed to improve academic achievement, should involve interactive lectures that encourage active learning; increase attention and motivation; give feedback to the teacher and the learner; and increase satisfaction for both (Steinert & Snell 1999:37).

In addition to using different educational approaches to facilitate the learning process, the intervention provides the following advantages:

1. By combining different educational strategies to facilitate the learning process, the intervention can be used as an interactive educational model that provides a theoretical base for radiography education, since learners generate the information themselves in response to the activities.
2. It further gives the learners the opportunity for self-discovery, which leads to a motivation to learn.
3. The group activities promote cooperative learning, an approach that facilitates teamwork in the profession.
4. This interactive approach results in "deep" rather than rote learning since the learner - through active involvement - generates information.

5.9 CONCLUSION

The overall goal of the study was to make a contribution towards optimising the effectiveness of education and training in the radiography programme in the School of Health Technology at the Technikon Free State. The information collected was used to develop an educational strategy which will enable learners from diverse backgrounds to improve their academic performance. Since there is a lack of research evidence on the extent and effectiveness of interactive instruction in radiography education, the problem statement of the study seems important and the results presented in this study suggest that the majority of learners in the target group experienced educational benefits.

Higher education in South Africa has been forced to respond to the massification of education (Makoni 2000:98). This resulted in the increased access of previously disadvantaged learners to the TFS. As mentioned in Chapter 2, moving away from the didactic teacher-student model is claimed by various educational researchers to be the way forward in addressing the access-success imbalance mentioned by Minister Kader Asmal in February 2003 who stated that the majority of learners who enrolled at tertiary institutions in South Africa did not graduate. The draft planning document of the APBC of the TFS, submitted in April 2003 (TFS 2003:1), claims that the key to learning improvement is embedded in the engagement of learners in active and collaborative learning experiences. This productive interaction between learners and facilitators extends educational events which promote academic achievement. This commentary in the document supports the importance of the effect and results of the current investigation, since it promotes the fundamental principle on which the aim, goal and design were based.

The TFS claims that a "superior learner-centred educational environment", determined by the productive interaction between learners and academic staff, should be the future approach to teaching and learning. The current study already explored the potential benefits thereof in 2002 and the findings are therefore in accord with the trend that learning rather than instruction should be "at the heart of higher education". The approach urged by Barr and Tagg (1995:13) that educational institutions exist not to give instruction, but to produce learning, is therefore merited. The authors state that, in an instruction paradigm, a specific methodology determines the limitation of what educators can do in contrast to the learning paradigm where learner learning and achievement set the limit.

Since OBET places increased demands on learner-centred learning and learner independence where it is expected from the learner to be more self-regulated, self-regulation has come forward as a key variable to shed light on academic achievement. The theories and processes of self-regulation were made known qualitatively and evaluated quantitatively. They were found to be highly predictive of academic motivation and achievement (Zimmerman 1998:84). From the perspectives gained in the investigation, it is concluded that, although active learner participation is valued to solve academic failure, the findings of the study also suggest that a shift from facilitator to learner could not be reached easily. This fact was mentioned in Chapter 1, namely that learners from diverse and academically deprived backgrounds require more support and encouragement in taking advantage of active learning and teacher support (Holsgrove *et al.* 1999:99) - a fact also noted by the CTM (2001b:15): "Learners might initially require more support and consultation opportunities before they master self-directed learning".

The aim of the study was to explore the impact of an interactive education strategy in radiography education, measured by summative assessment and learner perception. In reaching the aim and objectives, the intervention is considered to have a positive outcome derived from the results of the current investigation. As a result, this interactive approach according to which the facilitator and the learner actively take part in the learning process, rather than just a learner-centred approach to education, was found to be of value. It should thus be pursued in the future. These results could also have application to other learning programmes, particularly those that face the challenge of providing an optimal learning environment for learners from diverse backgrounds.

Increased access to higher education to address equity is a major objective of the NPHE (RSA MoE 2001). This increased access necessitated more flexible entry requirements to admit previously disadvantaged learners. These learners are, however, inadequately prepared for higher education. According to McLean (2001:408) past political and historical factors are responsible for the fact that these learners are under prepared and, as a result, their academic development is obstruct. The South African Universities Vice-Chancellors' Association (SAUVCA) insists that institutions take this into account in teaching and learning (SAUVCA 2002:6). Therefore the mere expansion of access to higher education must be broadened to embrace the idea of access to academic success.

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APPENDICES

A. MEASUREMENT

APPENDIX I

Learning Preference Inventory (LPI)

(Rezler 1974:101)

APPENDIX I

LEARNING PREFERENCE INVENTORY (LPI)

Rezler (1974:101)

This inventory gives you the chance to indicate those conditions or situations which most facilitate your learning (improve your marks). It is not a test; there are no right or wrong answers. The aim of the Inventory is to describe how you learn, not to evaluate your learning ability.

The Inventory has two parts.

In Part I there are six sets of six words listed.

In Part II there are nine items each of which contain six statements.

Instructions for answering Part I

Record all of your answers on the Answer Sheet for Part I

Read all six words carefully in Column A and rank order them.

Write 6 for the word in Column A that best promotes your learning; write 5 for the word that promotes learning the next best, and so on, until you write 1 for the word that promotes learning the least of all.

Be sure to assign a different rank to each of the six words in Column A and continue the same procedure for the remaining column until all words are ranked.

The following example illustrates the ranking procedure:

Rank the following colours in the order in which you prefer them:

Column A

a. Yellow
b. Green
c. Blue
d. Red
e. White
f. Black

Answer sheet:

Column A

a. 6
b. 3
c. 4
d. 5
e. 2
f. 1

You are to rank the responses and mark answers to each word in Part I (Columns A through F) in the same way.

Rank each word; please do not omit any.

Be sure to assign a different rank to each of the six words in each column.

LEARNING STYLE INVENTORY Part I

Promotes learning most for you	**6.**
Promotes learning second-best	**5.**
Promotes learning third-best	**4.**
Promotes learning fourth-best	**3.**
Promotes learning fifth-best	**2.**
Promotes learning least for you	**1.**

Column A	Column B	Column C
a. Factual	a. Self-instructional	a. Sharing
b. Teacher-directed	b. Myself	b. Doing
c. Teamwork	c. Hypothetical	c. Guided
d. Reading	d. Interpersonal	d. Self-initiated
e. Self-evaluation	e. Teacher defined	e. Thinking
f. Theoretical	f. Practical	f. Solitary

Column D	Column E	Column F
a. Teacher structured	a. Scientific	a. Individual
b. Concrete	b. Assigned	b. Applied
c. Writing	c. Skill-oriented	c. Supervised
d. Reading	d. Personal	d. Autonomous
e. Group	e. Self-designed	e. Abstract
f. Self-directed	f. Team-oriented	f. Interactive

LEARNING STYLE INVENTORY ANSWER SHEET

Column A		Column B		Column C	
(26)	a.	(32)	a.	(38)	a.
(27)	b.	(33)	b.	(39)	b.
(28)	c.	(34)	c.	(40)	c.
(29)	d.	(34)	d.	(41)	d.
(30)	e.	(35)	e.	(42)	e.
(31)	f.	(36)	f.	(43)	f.

Column D		Column E		Column F	
(44)	a.	(50)	a.	(56)	a.
(45)	b.	(51)	b.	(57)	b.
(46)	c.	(52)	c.	(58)	c.
(47)	d.	(53)	d.	(59)	d.
(48)	e.	(54)	e.	(60)	e.
(49)	f.	(55)	f.	(61)	f.

LEARNING STYLE INVENTORY PART II

6 = Promotes learning most for you
5 = Promotes learning second-best
4 = Promotes learning third-best
3 = Promotes learning fourth-best
2 = Promotes learning fifth-best
1 = Promotes learning least for you

1. Read the following six statements and then rank them in terms of how well they describe the teachers in whose classes you have done the best.

a. The teacher gave many practical, concrete examples.
b. The teacher let me set my own goals and try different approaches to reach them.
c. The teacher encouraged me to work by myself.
d. The teacher was friendly and outgoing.
e. The teacher made the relationships between different thoughts clear.
f. The teacher made clear and definite assignments, and I knew exactly what was expected.

2. Number the following work in the order in which they would interest you.

a. Work that would require cooperation among team members.
b. Work with specific and practical ways of handling things.
c. Work that would let me do things on my own.
d. Work that would permit me to deal with ideas rather than things.
e. Work that I could plan and organise myself.
f. Work that would be clearly defined and specified by my supervisor.

3. Rank the following in terms of their effects on how hard you work and how much you accomplish in a class.

a. I can set my own goals and proceed accordingly.
b. I can address myself to a concrete, practical task.
c. I have an opportunity to discuss or work on something with other students.
d. I can examine different schools of thought.
e. I understand what is expected and how it will be evaluated.
f. I can accomplish most tasks by myself.

4. The evaluation of student performance is a part of nearly all courses. Rank the following in terms of how you feel about such evaluation.

a. It should be assembled from questions provided by students.
b. It should focus on individual performance.
c. It should consist of a written examination dealing with written concepts.
d. It should consist of a practical examination dealing with skills.
e. It should be consistent with clearly specified requirements.
f. It should not interfere with relationships between teacher and student.

5. Rank the following in terms of their general value to you as ways to learn.

a. Study a textbook.
b. Engage in an internship or practicum.
c. Prepare a class project with other students.
d. Search for reasons to explain occurrences.
e. Follow an outline prepared by the teacher.
f. Prepare your own outline.

6. Rank the following in terms of how much they would attract you to an elective class.

a. Good personal relationships between teacher and students.
b. Clearly spelled-out standards and requirements.
c. Emphasis on practising skills.
d. Emphasis on individual study.
e. Opportunity to determine own activities.
f. Emphasis on theoretical concepts.

7. Consider the following in terms of their general effect on how well you do in a class.

a. I can study on my own.
b. I can work with something tangible.
c. I can focus on ideas and concepts.
d. I can organise things my own way.
e. I can work with others.
f. I can work on clear-cut assignments.

8. Rank the following in the order in which you think teachers should possess these characteristics or skills.

a. Getting students to set their own goals.
b. Getting students to demonstrate concrete skills.
c. Involving students in generating hypotheses.
d. Preparing of self-instructional materials.
e. Relating well to students.
f. Planning all aspects of courses and learning activities.

9. Rank the following in terms of how much they generally help you learn and remember.

a. Studying alone instead of studying with fellow-students.
b. Performing a specific task.
c. Having a knowledgeable teacher discuss the theory upon which a practice is built.
d. Determining your own approach and proceeding accordingly.
e. Joining a student group to study together and share ideas.
f. Getting an outline of the course from the teacher and a clear understanding of what will occur in the course

LEARNING STYLE INVENTORY ANSWER Sheet PART II

Item 1	
(26) a.	
(27) b.	
(28) c.	
(29) d.	
(30) e.	
(31) f.	

Item 2	
(32) a.	
(33) b.	
(34) c.	
(35) d.	
(36) e.	
(37) f.	

Item 3	
(38) a.	
(39) b.	
(40) c.	
(41) d.	
(42) e.	
(43) f.	

Item 4	
(44) a.	
(45) b.	
(46) c.	
(47) d.	
(48) e.	
(49) f.	

Item 5	
(50) a.	
(51) b.	
(52) c.	
(53) d.	
(54) e.	
(55) f.	

Item 6	
(56) a.	
(57) b	
(58) c.	
(59) d.	
(60) e.	
(61) f.	

Item 7	
(62) a.	
(63) b.	
(64) c.	
(65) d.	
(66) e.	
(67) f.	

Item 8	
(68) a.	
(69) b.	
(70) c.	
(71) d.	
(72) e.	
(73) f.	

Item 9	
(74) a	
(75) b	
(76) c.	
(77) d.	
(78) e.	
(79) f.	

SUMMARY SHEET

Use this page to summarise your scores.
Each of the numbers in Parts I and II below corresponds to items in the Questionnaire. For each item, write the rank (from 1-6).
After filling in your ranks, total them separately for Parts I and II.
At the bottom of the page, combine the totals of both parts. To check the accuracy of your calculations, the bottom total of 6 columns should be 315.

PART I

	AB	CO	TS	SS	IP	IN	
	(31)	(26)	(27)	(30)	(28)	(29)	
	(34)	(37)	(36)	(32)	(35)	(33)	
	(42)	(39)	(40)	(41)	(38)	(43)	
	(48)	(45)	(44)	(49)	(47)	(46)	
	(50)	(52)	(51)	(54)	(55)	(53)	
	(60)	(57)	(58)	(59)	(61)	(56)	
Part I Subtotal:							= 126

PART II

	AB	CO	TS	SS	IP	IN	
	(30)	(26)	(31)	(27)	(29)	(28)	
	(35)	(33)	(37)	(36)	(32)	(34)	
	(41)	(39)	(42)	(38)	(40)	(43)	
	(46)	(47)	(48)	(44)	(49)	(45)	
	(53)	(51)	(54)	(55)	(52)	(50)	
	(61)	(58)	(57)	(60)	(56)	(59)	
	(64)	(63)	(67)	(65)	(66)	(62)	
	(70)	(69)	(73)	(68)	(72)	(71)	
	(76)	(75)	(79)	(77)	(78)	(74)	
Part II Subtotal:							= 189
TOTALS:							= 315

Description of categories:

Abstract (AB): preference for learning theories, general principles, concepts, and generating hypotheses.

Concrete (CO): Preference for learning tangible, specific, practical tasks and skills.

Teacher-structured (TS): Preference for well-organised, teacher-directed classes with clear expectations, assignments, and goals defined by the teacher.

Student-structured (SS): Preference for learner-generated tasks, autonomy and self-direction.

Interpersonal (IP): Preference for learning or working with others; emphasis on harmonious relations between students and teacher and among students.

Individual (IN): Preference for learning or working alone, with emphasis on self-reliance and tasks which are solitary, such as reading.

APPENDIX II

Pre-Intervention test

(Bontrager 1993:237)

APPENDIX II

PRE-INTERVENTION TEST

Technikon Vrystaat • Free State • Foreistata

Toets/Test

SKEDEL/*SKULL*

SKOOL vir GESONDHEIDSTEGNOLOGIE

SCHOOL of HEALTH TECHNOLOGY

ONDERRIGPROGRAM: Radiografie

VAK: Radiografiese Praktyk II

KODE: RAD 20 at

INSTRUCTIONAL PROGRAMME: Radiography

SUBJECT: Radiographic Practice

CODE: RAD 20 at

DOSENT/*LECTURER*: S.M.Brüssow

DATUM/*DATE*: 2002-05-17

TYD/*DURATION*: 120 min.

MAKSIMUM PUNTE/*MAXIMUM MARKS*: 142

INSTRUKSIES/*INSTRUCTIONS*: Beantwoord al die vrae/ *Answer all the questions*

Naam/*Name*: ________________________

Student Nr.:____________________

1. The calvarium is formed primarily by the following four cranial bones:

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

2. The following four cranial bones primarily make up the "floor" of the cranium:

E. ______________________________

F. ______________________________

G. ______________________________

H. ______________________________ 8

Matching: (You may indicate more than one choice)

3.	__	Auricle	A. Gonion
4.	__	External occipital protuberance	B. Nasion
5.	__	Prominence between eyebrows	C. TEA
6.	__	Centre of triangle of chin	D. Infraorbital margin
7	__	Groove above eyebrows	E. Pinna
8.	__	Depression at bridge of nose	F. Supraorbital groove
9.	__	Top of ear attachment	G. Acanthion
10.	__	Medial junction of eyelids near nose	H. EAM
11.	__	Superior rim of orbit	I. Inion
12.	__	External landmark-petrous ridge	J. Vertex
13.	__	Inferior rim of orbit	K. Inner canthus
14.	__	Midline of junction of upper lip-nose	L. Supraorbital margin
15.	__	Lateral portion of orbital rim	M. Mental point
16.	__	Landmark-highest level of facial bones	N. Infraorbitomeatal line

17.	___	External landmark corresponding to highest level of facial bone mass	O. Orbitomeatal line
18.	___	Reid's base line	P. Glabella
19.	___	Line between outer canthus and EAM	
20.	___	Most superior portion of cranium	
21.	___	Bump at lower posterior cranium	
22.	___	External landmark-floor of cranium	

20

Matching: (Match the following with the correct cranial bone)

23.	___	Lies primarily under floor of cranium	Temporals	(T)
24.	___	Houses organs of hearing	Parietals	(P)
25.	___	Crista galli	Frontal	(F)
26.	___	Styloid process	Occipital	(O)
27.	___	Sella turcica	Sphenoid	(S)
28.	___	Inion	Ethmoid	(E)
29.	___	Mastoid process		
30.	___	Dorsum sellae		
31.	___	Pterygoid process		
32.	___	Zygomatic process		
33.	___	Labyrinths		
34.	___	EAM		
35.	___	Perpendicular plate		
36.	___	Turbinates		
37.	___	Foramen magnum		
38.	___	Cribirorm plate		

39. __ Orbital plate

40. __ Lesser wing

41. __ Glabella

42. __ Petrous pyramids

43. __ Clivus

44. __ Lateral conylar portions

45. __ Foramen rotundum, ovale and spinosum

<u>23</u>

46. Fill in the following according to the drawings:

A. ____________________

B. ____________________

C. ____________________

D. ____________________

E. ____________________

F. ____________________

G. ____________________

H. ____________________

I. ____________________

J. ____________________

K. ____________________

L. ____________________

M. ____________________

N. ____________________

O. ____________________

P. ____________________

Q. ____________________

R. ____________________

S. ____________________

T. ____________________

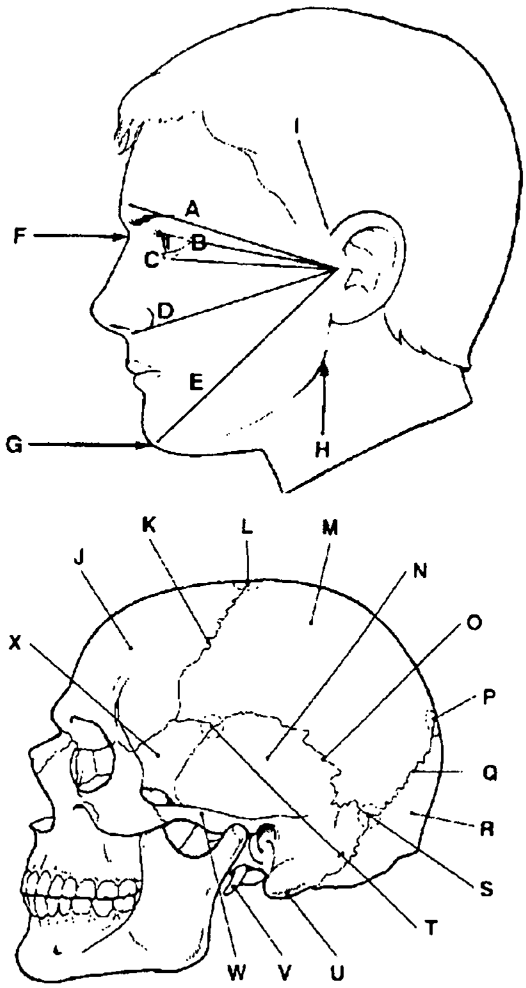


Fig. 11-8

U. ________________

V. ________________

W. ________________

X. ________________ 24

47. Indicate the number of adjoining cranial bones with which each of the following bones articulate:

A. Frontal	C. Occipital	E. Sphenoid
B. Each parietal	D. Each temporal	F. Ethmoid

48. Complete the following for the correct shape classifications and the degrees of angle between the petrous pyramids and the midsagittal plane:

A. Average shaped head (a) __________ (b) ____degrees.

B. Long narrow head (a) ______________ (b) ____ degrees.

C. Short broad head (a) ______________(b) ____ degrees.

49. Describe how you would locate the sella turcica from external landmarks ____ .

50. What are the two lines or planes which should be checked carefully to insure a true lateral skull position?

A. ____

B. ____

51. List the additional terms commonly used to describe the following projections of the skull:

A. PA, 15 caudal angle_________________

B. AP axial ___________________________

C. Basilar ____________________________

52. Describe how to locate the correct central ray location for a lateral skull if the entire cranium is to be centred to the film.

____

53. How can a person determine by critiquing radiographs if the correct angle of the central ray was used for the following projections of the cranium:

A. Pa Caldwell? ______________________

B. AP axial for sella turcica (30 caudal to IOML)? __________

C. AP axial for sella turcica (37 caudal to IOML)? __________

D. Submentovertex? ______________________

54. For an AP axial (Towne) projection as part of a routine skull series, which line of the skull should be perpendicular to the film if:

A. A 30 caudal angle is used? ______________________

B. A 37 caudal angle is used? ______________________

55. On a submentovertex projection, the ______________________ line must be parallel to the plane of the film.

56. List the structures best demonstrated on the following cranial projections:

A. Submentovertex ______________________

B. AP axial (30^0) ______________________

57. Which two projections best demonstrate the petrous pyramids (ridges)?

A. ______________________

B. ______________________

58. What single projection best demonstrates the sella turcica and clivus?

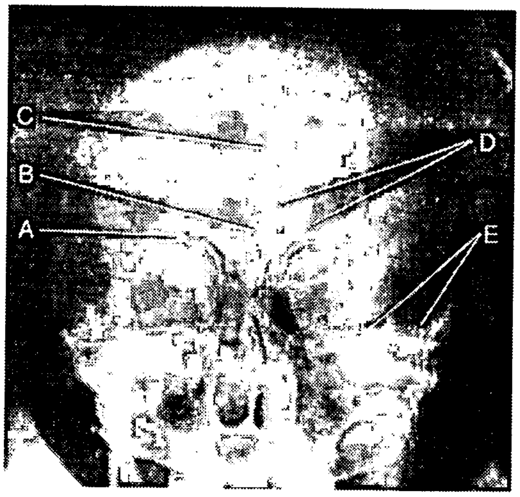
____

59. Which projection best demonstrates the internal auditory canals?

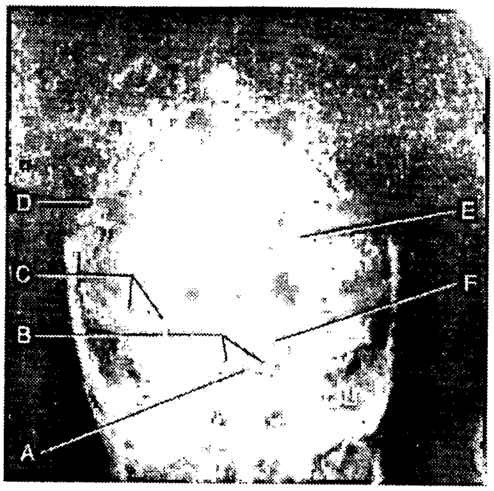
____

60. Label the following radiographs:

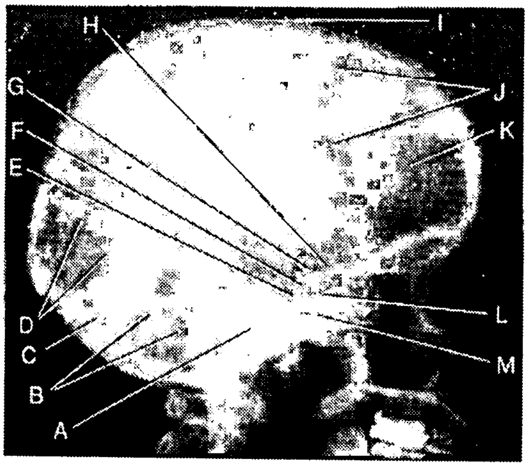
I



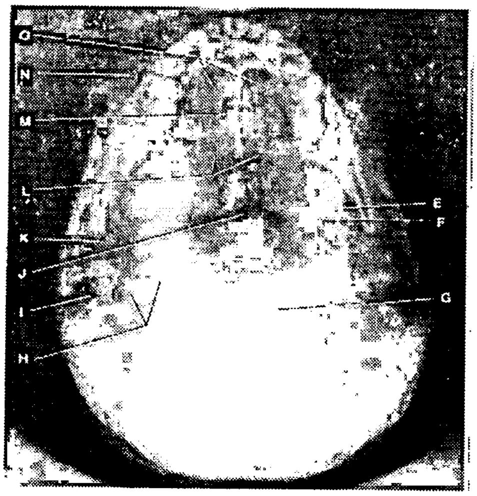
II



III



IV



35

APPENDIX III

Post-intervention test

(Bontrager 1993:261)

APPENDIX III

POST-INTERVENTION TEST

Technikon Vrystaat • Free State • Foreistata

Toets/Test

GESIGSBENE/*FACIAL BONES*

SKOOL vir GESONDHEIDSTEGNOLOGIE

SCHOOL of HEALTH TECHNOLOGY

ONDERRIGPROGRAM: Radiografie

VAK: Radiografiese Praktyk II

KODE: RAD 20 at

INSTRUCTIONAL PROGRAMME: Radiography

SUBJECT: Radiographic Practice

CODE: RAD 20 at

DOSENT/*LECTURER*: S.M.Brüssow

DATUM/*DATE*: 2002-05-17

TYD/*DURATION*: 120 min.

MAKSIMUM PUNTE/MAXIMUM MARKS: 157

INSTRUKSIES/*INSTRUCTIONS*: Beantwoord al die vrae/ Answer all the questions

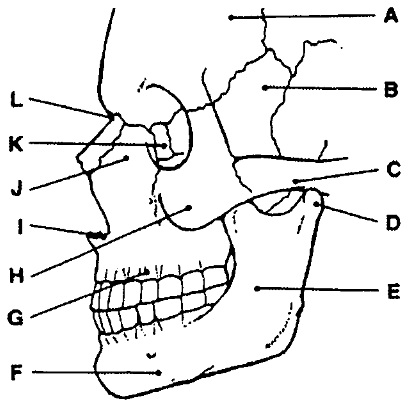
Naam/*Name*: ______________________

Student Nr.:__________________

A.

1. Identify the labelled anatomy and list the name of which bone it is part where indicated

	Anatomical part	Facial/Cranial bone
A.	____________	
B.	____________	__________
C.	____________	__________
D.	____________	__________
E.	____________	__________
F.	____________	__________
G.	____________	__________
H.	____________	
I.	____________	__________
J.	____________	__________
K.	____________	
L.	____________	



2. Fill in the names of the three openings of the orbits.

A. ______________________

B. ______________________

C. ______________________

3. The small root of bone forming the lateral wall of the optic canal, important in radiology, is the ________________________.

A. Maxillae
B. Zygomatic bones
C. Lacrimal bones
D. Nasal bones
E. Mandible
F. Vomer
G. Palatine bones
H. Inferior nasal conchae

Matching: Match the correct facial bone(s) for the following:

4. __ bony nasal septum

5. __ frontal process

6. __ nasion

7. __ maxillary sinuses

8. __ form the three facial cavities

9. __ alveolar process

10. __ zygomatic process

11. __ malar bones

12. __ largest immovable bone

13. __ tear ducts

14. __ palatine processes

15. __ zygomatic arches

16. __ largest facial bone

17. __ anterior hard palate

18. __ posterior hard palate

19. __ turbinates

20. __ anterior nasal spine

21. __ coronoid process

22. The two common types of fractures involving the orbits are:

A. ______________________________

B. ______________________________

23. Identify the names of the bones and the openings as labelled on this drawing of the orbit.

A. ______________________

B. ______________________

C. ______________________

D. ______________________

E. ______________________

F. ______________________

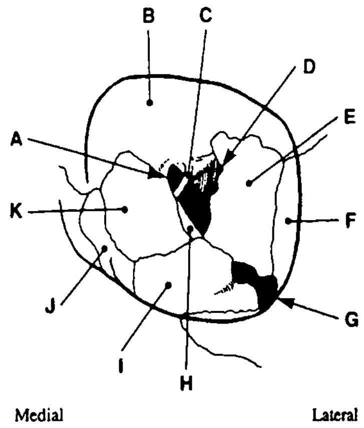
G. ______________________

H. ______________________

I. ______________________

J. ______________________

K. ______________________



24. Which two structures make up the bony nasal septum?

A. ______________________________

B. ______________________________

25. What is the name of the projection describing the PA Waters position? ____________________.

26. What anatomical part is best demonstrated on the following?

A. Waters ____________________

B. Modified Waters ______________

C. Rhese position _______________

27. Which two anatomical parts or areas should be superimposed in an optimal modified parietoacanthial projection? (a) ________ and (b)_____________ .

28. Which two anatomical parts or areas should be superimposed in an optimal Waters position? (a) _________ and (b) _________.

29. List the name of the position taken in place of the Waters for the patient with possible spinal injuries who cannot be turned prone, and describe how it would be done ________________.

30. How can rotation be determined on a radiograph taken in either the Waters or modified Waters positions? ________________.

31. List the degrees of angle between the orbitomeatal line and the plane of the film for:

A. Waters position _____ degrees

B. Modified Waters position _____ degrees

32. For an oblique axial position for the right zygomatic arch, the _____ line is perpendicular to the central ray and the head is rotated _____ degrees towards the affected side.

33. Complete the following for the special projection to demonstrate the optic foramina as demonstrated by the drawings in Figs.12-9 and 12-10.

A. The correct name for this projection.

B. The popular common name for this projection.

C. As a starting reference position, name the three "points" which should be touching the table. ____, ____ and _____.

Fill in the correct angles from the following drawings:

D. _____ degrees

E. _____ degrees

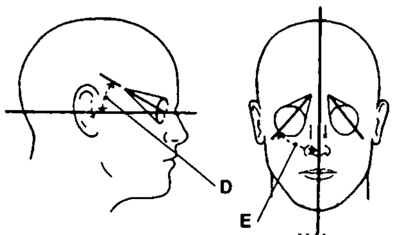


Fig. 12-9

F. _____ degrees

G. _____ degrees

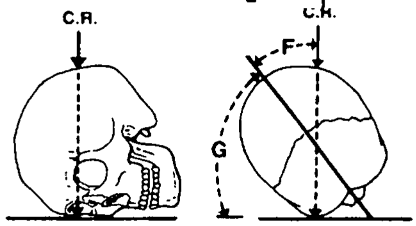


Fig. 12-10

H. Name the positioning line that is parallel to the central ray.

I. The position demonstrated in Fig. 12-9 will demonstrate the (a) _ (R/L) optic foramen within the (b) __Quadrant of the orbit.

34. A good submentovertex projection requires that the central ray be at right angles to the __________________ line.

35. Complete the following for an AP axial projection (Townes) for the zygomatic arches:

A. Central ray should enter head at ________________.

B. Tuck the patient's chin, bringing the _______line perpendicular to the film.

C. The central ray should be angled ____ degrees _____ (caudal or cephalad).

36. The correct central ray for a reverse Waters is to the _______.

37. In a Waters position, the _______ line should be perpendicular to the plane of the film.

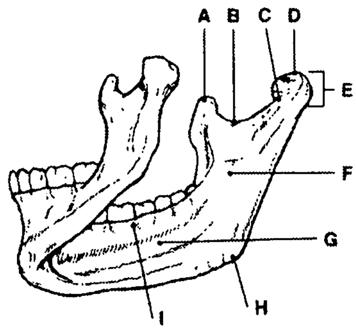
38. A. The triangular area of the mandible projecting anteriorly is called the ____________.

B. The centre of this triangle is the __________________.

39. The (a) _____ of the mandible fits into the _____ fossa (b) of the (c) _______ bone to form the (d) _______ joint, abbreviated (e) ___.

40. Fill in the following anatomy:

A. ________________
B. ________________
C. ________________
D. ________________
E. ________________
F. ________________
G. ________________
H. ________________
I. ________________



41. What is the centering point for the PA projection of the mandible? ________

42. Describe how you would position for an axiolateral oblique mandible for the right mandibular body ______________________________.

43. For an axiolateral or oblique mandible the central ray is angled ____ degrees ______ (caudal or cephalad).

44. What is the name of the basic projection which demonstrates the mandibular rami and lateral portion of body? _______________.

45. What projection best visualises the upper rami and condyloid processes of the mandible? ____________________

46. Name the two basic positions/projections for radiographing the temporomandibular joints (include the common name for each.)

A. __________ (__________)

B. __________ (__________)

47. Why are temporomandibular radiographs taken bilaterally and in both the open and closed mouth position? ______________

48. Should the open and closed positions be attempted in TMJ radiography if the patient has a possible fracture of the mandible?

____

49. Positioning for the axiolateral oblique (Law) position requires a double ______ degree angle. (Head rotation and CR angle.)

50. Positioning for an axiolateral (Schuller) position requires a ______ degree (caudal or cephalic) CR angle with the head in a true lateral position. 10

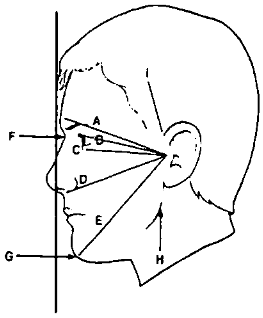
B. Review of anatomy on radiographs

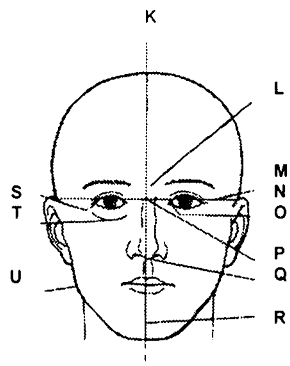
Identify the following anatomical parts on radiographs attached p. 9:

- greater wings of the sphenoid - orbital roofs
- sella turcica - zygoma
- mandible - inferior rim of orbit
- maxillae - nasal septum
- zygomatic arches - anterior nasal spine
- orbital rim - nasal lxfties
- optic foramen - mandibular rami
- temporomandibular joints - condyloid processes of mandible
- coronoid process of mandible - temporomandibular fossae
- petrous ridges

C. Review of topographical landmarks and positioning lines

Locate the following:





__ 1. Midsagittal plane

__ 2. Interpupillary line

__ 3. Zygoma

__ 4. Outer canthus

__ 5. EAM

__ 6. Mentomeatal line

__ 7. Acanthion

__ 8. Orbitomeatal line

__ 9. Infraorbitomeatal line

__ 10. Glabelloalveolar line

__ 11. Mandibular symphysis

__ 12. Angles of the mandible

__ 13. Glabella

__ 14. Zygomatic arch

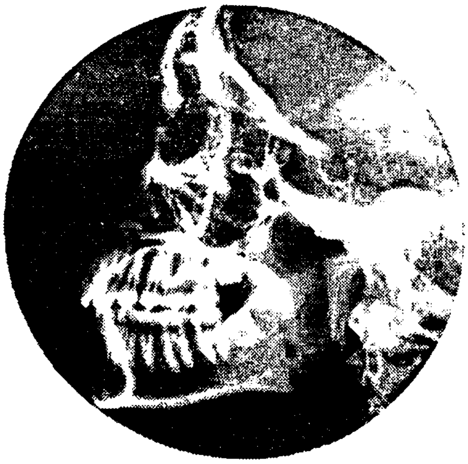
__ 15. Zygomatic prominence

__ 16. Three-point for Rhese method

__ 17. Superciliary arch

Radiographs (B)

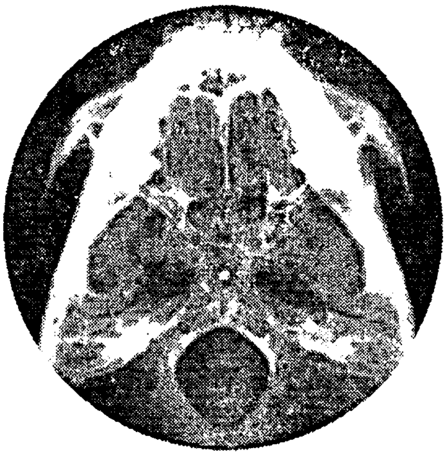
Lateral



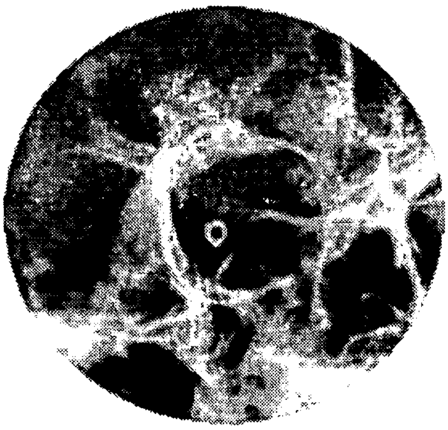
Parietoacanthial

PA Caldwell

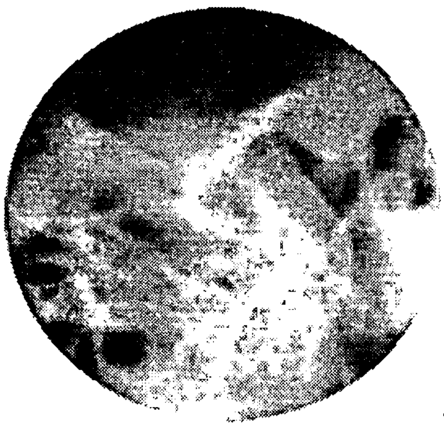
Submentovertex



Rhese oblique



Schuller method



APPENDIX IV

Learner questionnaire

APPENDIX IV

LEARNER QUESTIONNAIRE

This questionnaire is developed to determine which factors can improve your marks.
This questionnaire is anonymous to afford you absolute freedom in your answers.
Please provide frank and honest answers. Answer all questions.
Please indicate with an "X" in the block next to the appropriate answer.

1. DEMOGRAPHICS

1.1 What is your gender?

Male	
Female	

1.2 To which population group do you belong?

Asian	
Black	
Coloured	
White	

1.3 Your age:

20	
21	
22	
23	
older	

1.4 What language do you speak at home most often?

English	
Afrikaans	
Sotho	
Other (Specify):	

1.5 Name the school and area where you completed your high school training.

Town:	School:

2. TEACHING METHOD

	Which of the following will improve your marks?	Yes	No
2.1	Formal lectures without learner participation.		
2.2	Independent self-study.		
2.3	Lecture interactive activities in class.		
2.4	Group activities.		
2.5	Independent individual activities.		
2.6	Fellow-learner presentations.		
2.7	Individual assignments.		
2.8	Group assignments in class.		

3. ROLE OF THE LECTURER			
Is the lecturer important to you to increase your marks?		**Yes**	**No**
3.1	Providing information and knowledge.		
3.2	Supplying notes.		
3.3	To guide and structure self-study.		
3.4	To promote interaction during formal lectures.		
3.5	The lecture participation influence your marks.		
3.6	Do you prefer the lecturer not to be active in class?		
3.7	Do you learn more if the lecturer is active in the learning process?		

4. STUDY METHODS			
Do you use the following study methods?		**Yes**	**No**
4.1	Just read through information in your text book once.		
4.2	Read through information in your text book a few times.		
4.3	Make summaries.		
4.4	Draw mind maps of important information.		
4.5	Prefer to use just lecturers notes.		
4.6	Use lecturers notes with other methods.		
4.7	Like to study in groups.		
4.8	Study directly after lectures.		
4.9	Study only for tests or exams.		

5. ASSESSMENT METHODS			
Which of the following assessment methods do you prefer?		**Yes**	**No**
5.1	Formal examinations.		
5.2	Formal tests.		
5.3	Integrated tests (all subjects in one test).		
5.4	Practical exams in the Radiographic laboratory.		
5.5	Practical exams in the Radiology Department/Practice.		
5.6	Assessment through assignments.		
5.7	OSCEs.		
5.8	Orals.		
5.9	Fellow-learner assessment.		
5.10	Through self-demonstrations.		
5.11	Through self-presentations.		

6. GENERAL			
Which of the following statements are true?		**Yes**	**No**
6.1	I am satisfied with my career choice.		
6.2	Own a relevant Merrill or Bontrager textbook.		
6.3	Use the library to obtain additional information.		
6.4	Use the library to obtain just the necessary information.		
6.5	Outside factors exist that influence my learning performance.		
6.6	I am satisfied with my marks.		

6.7	The lecturer play an important role in my learning process.		
6.8	The Year Organiser helps me to plan my learning.		
6.9	The learning guide is an important source of knowledge.		
6.10	I prepare for lectures.		
6.11	I often postpone learning.		
6.12	I prefer independent self-study to interactive lectures.		
6.13	I learn more from activities in class than just formal lectures.		
6.14	Interactive lectures promote my understanding of the subject.		
6.15	I like to take part in class discussions.		
6.16	I feel isolated during independent self-study.		
6.17	Activities improve my learning experience.		
6.18	The lecture must be a role model in the learning setting.		

7. EXPERIENCE

Finally I would like your comments and experiences with regard to teaching methods.
Which teaching method will improve your marks the most?
Rank the following teaching methods by filling in a number in the block provided with (1) as the most important, (2) as the second-most important, (3) as the third-most important, and so on.
(Only use a number once) **Rank: 1, 2, 3, 4, 5 & 6**

7.1	Independent self-study (autonomous learning).	
7.2	Formal lectures without interaction.	
7.3	Contact sessions with a variety of activities.	
7.4	Group discussions.	
7.5	Peer (fellow-learners) presentations.	
7.6	Lecturer demonstrations.	

8. PERSONAL

Which of the following statements are true in connection with factors influencing your learning?

		Yes	No
8.1	Cost of textbooks.		
8.2	Insufficient time to study.		
8.3	Poor time management (self).		
8.4	Poor concentration.		
8.5	Outside factors.		
8.6	Experiencing study stress.		
8.7	Experiencing work related-stress.		
8.8	Experiencing personal stress.		
8.9	Financial burdens.		
8.10	Others:		
	Specify:		

B. STUDY DESIGN

APPENDIX V

Division of learners and test scores

APPENDIX V

DIVISION OF LEARNERS AND TEST SCORES

Division according to average test scores*

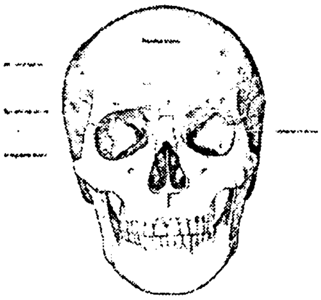
Learners	*Test scores	Formal lectures			Self-activities			Self-study		
		ASAT	Pre-test	Post-test	ASAT	Pre-test	Post-test	ASAT	Pre-test	Post-test
1	51.5							63.0	43.0	52.0
2	46.0	58.0	54.0	66.0						
3	48.5				66.0	33.0	59.0			
4	50.5				86.0	55.0	71.0			
5	39.5				34.0	38.0	51.0			
6	43.0	27.0	51.0	76.0						
7	50.0							37.0	47.0	66.0
8	77.0	98.0	80.0	85.0						
9	71.5	91.0	68.0	81.0						
10	86.0				96.0	75.0	85.0			
11	47.0	25.0	37.0	63.0						
12	67.5							68.0	62.0	74.0
13	64.0	81.0	69.0	66.0						
14	58.0	91.0	64.0	81.0						
15	69.5				81.0	51.0	73.0			
16	59.5							90.0	56.0	78.0
17	62.0	87.0	55.0	69.0						
18	56.5				55.0	25.0	75.0			
19	67.0	63.0	64.0	66.0						
20	67.0				92.0	50.0	83.0			
21	78.0							97.0	67.0	78.0
22	61.5	50.0	59.0	71.0						
23	55.0	25.0	52.0	72.0						
24	47.0				50.0	40.0	59.0			
25	52.0							63.0	39.0	76.0
26	47.0				34.0	41.0	58.0			
27	59.0							97.0	74.0	87.0
28	83.5				32.0	32.0	61.0			
29	57.5							77.0	33.0	72.0
30	36.5				18.0	30.0	57.0			
Count	30.0	11.0	11.0	11.0	11.0	11.0	11.0	8.0	8.0	8.0
Mean	58.6	63.3	59.4	72.4	58.5	42.7	66.5	74.0	52.6	72.9
Max	86.0	98.0	80.0	85.0	96.0	75.0	85.0	97.0	74.0	87.0
Min	36.5	25.0	37.0	63.0	18.0	25.0	51.0	37.0	33.0	52.0
Std	12.7	28.4	11.4	7.4	27.3	14.3	11.4	20.6	14.4	10.3

APPENDIX VI

Study group I: Formal lectures

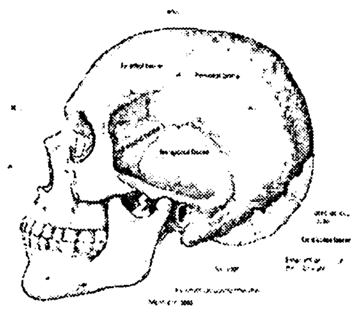
Figures and radiographs from *Merrill's Atlas of Radiographic Positions and Radiologic Procedures* (Ballinger & Frank 1999:231), *Radiographic Positioning and Related Anatomy* (Bontrager 1997:323) and *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual* (Bontrager, K.L. 1993).

Skull



Figures and radiographs courtesy of Ballinger & Frank Merrils Atlas of Radiographic Positions and Radiologic Procedures and Bontrager Radiographic Positioning and Related Anatomy.

Skull



Pathology

Fractures

Linear

Depressed

Basal skull

Neoplasm

Metastases

Osteolytic

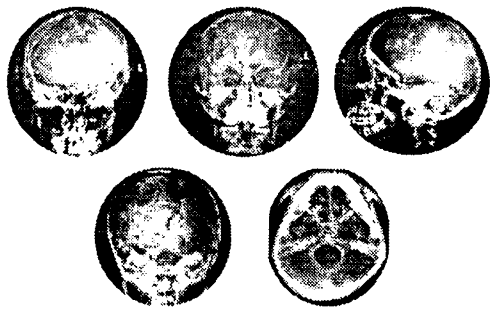
Osteoblastic

Multiple Myeloma

Pituitary adenomas

Paget's disease

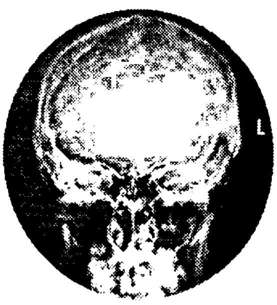
Skull series



OF 0⁰ Skull

Structures

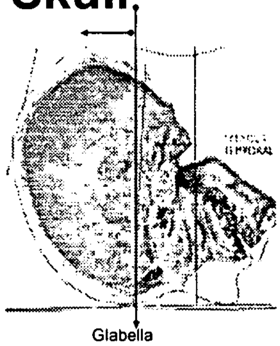
- Frontal bone
- Crista galli
- Frontal sinus
- Ethmoid sinus
- Petrous ridges
- Sphenoid wings
- Dorsum sellae



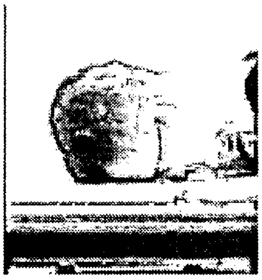
OF 0⁰ Skull

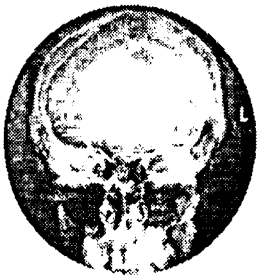
Part position

- Nose & forehead
- OML/Baseline
- No rotation
- No tilt
- MSP ⇳
- CR ⇳
- Exits → Glabella



OF 0^0 Skull





Evaluation criteria

Structures

Frontal Bone, Crista Galli, IAM, Frontal sinus, Petrous ridges, sphenoid wings, dorsum sellae

- Entire skull /No rotation
- Petrous pyramids orbits
- Obl.Orb.line=skull margin
- P & A clinoids superior ethmoid

PA axial 15^0

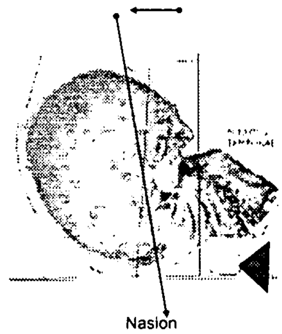
Structures

- Frontal bone
- Crista galli
- Frontal & ethmoid
- Petrous ridges
- Sphenoid wings
- Foramen rotundum
- Sup. Orb fissures
- IAM
- Orbital margin

PA 15^0 Skull

Part position

- Nose & forehead
- OML
- No rotation
- No tilt
- MSP
- Baseline
- CR 15^0 ext nasion



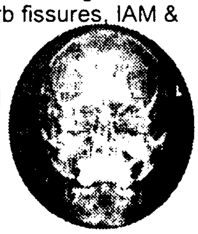
PA 15^0 Skull

PA 15^0 / 25^0 - 30^0

Evaluation criteria

Structures

- Frontal bone, Crista galli, Frontal & Ethmoid sinus, Petrous ridges, Sphenoid wings, Foramen rotundum, Sup. Orb fissures, IAM & Orbital margin
- Entire skull, No rotation/tilt:
  - Obl.orbital margin=lat.skull
  - Sup. Orb.fis. =
- Petrous ridge → 1/3 orbit
- Colli: margin of skull
- Nasion in centre



AP axial 30^0 Towne

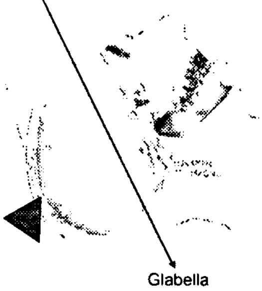
Structures

- Occipital bone
- Petrous pyramids
- Foramen magnum
- → Dorsum sellae
  Post. clinoids

AP axial 30^0 Towne

Part position

- MSP & OML ⇔
- OML → CR 30^0
- IOML → CR 37^0
- No rotation / tilt
- ⊕ 6cm ↕



Towne

Evaluation criteria

- Entire skull
- No rotation:// Foramen Magnum and lat.marg.skull
- Petrous ridge superior to mastoids
- Petrous ridges symmetrical
- Dorsum sellae & Post. clinoids inside Foramen magnum

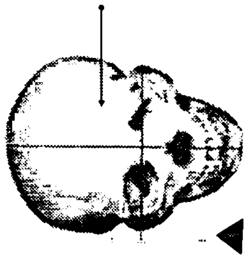
Lateral Skull

Structures

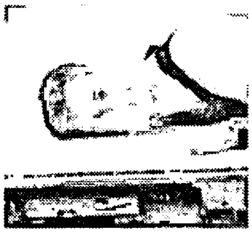
- Total cranium R/L
- Sella turcica
- A & P clinoids
- Dorsum sellae
- Wings of sphenoid

Lateral Skull

Part position
- True lateral
  Glabelle/Nasion =
  Occ.protuberance
- No rotation/tilt
- MSP ⊥
- Baseline / GAL
- CR 5cm ⇧ EAM



Lateral skull

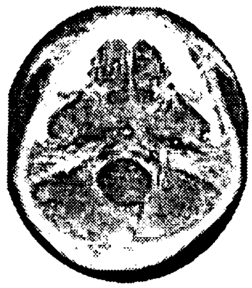


Evaluation criteria

- Entire skull
- No rotation/tilt
  Mand. Rami, EAM
  Orbital roofs
  Sella turcica ✥
  A & P clinoids
  Dorsum sellae
  Wings of sphenoid
- GAL // to film edge

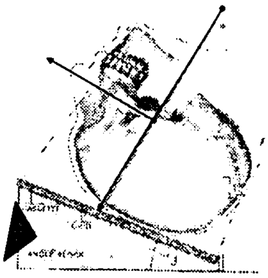
Submentovertex

Structures
- Occipital bone
- Foramen magnum
- Foramen ovale
- Foramen spinosum
- Mandible
- Sphenoid & Ethmoid
- Mastoid
- Hard palate
- Petrous ridge

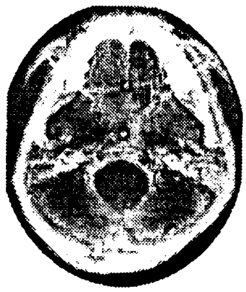


Submentovertex

Part position
- Hyper extension
  Glabelle/Nasion =
  Occ.protuberance
- No rotation / tilt
- MSP ⊥
- Baseline ⊥
- CR 2cm ⇧ EAM
- IOML

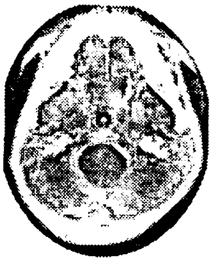


SMV



Evaluation criteria

Entire skull
No rotation/tilt
- Mandible Condyles anterior to petrous ridges
- Mand. Symph. frontal bone ✥
- Mandibubalar= border
Foramen ovale visible
- Foramen spinosum visible



Trauma Skull

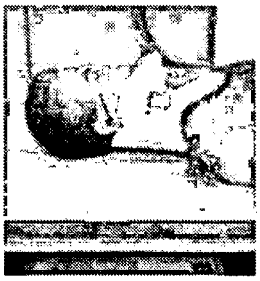
- Lateral without head manipulation
- MSP //
- IPL ✥
- CR ⇩
- ⊕ 5cm ↕ EAM

Trauma Skull

- Lateral after Cervical injury has been ruled out
- MSP //
- IPL ✥
- CR ⇩
- ⊕ 5cm ↕ EAM

AP 0^0 to OML

- AP
- MSP ⊕ to film
- CR // to OML
↓ 10-15^0
- ⊕ Glabella
- CR ⊕ IR



AP 15^0 to OML

Reverse Caldwell
- AP
- MSP ⊕ to film
- CR 10-15^0 to OML
- ⊕ Nasion
- CR ⊕ IR

AP Axial Towne

- AP
- MSP ⊕ to film
- ↓ CR 30^0 to OML
- Superciliary arch
- CR ⊕ IR & EAM

Bontrager, K.L. 1993. *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual.* Vol. 1, 3rd ed. U.S.A: St Louis. Mosby. 217-268.

Bontrager, K.L. 1997. *Radiographic Positioning and Related Anatomy.* 4th ed. U.S.A., St Louis: Mosby. 323-358.

Ballinger, P.W. & Frank, E.D. 1999. *Merrill's Atlas of Radiographic Positions and Radiologic Procedures.* 9th ed. U.S.A., St Louis: Mosby. 231-307.

APPENDIX VII

Study group II: Self-activities

Activities, figures and radiographs from *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual.* Vol. 1, 3rd ed. U.S.A: St Louis. Mosby. (Bontrager1993:217-268).

APPENDIX VII

STUDY GROUP II: SELF-ACTIVITIES

SKULL

1. INTRODUCTION

Radiographic examinations involving the skull are usually considered among the most difficult of all examinations. The skull is a very compact structure involving many small but important bony or superimposed by other structures of the skull. This makes it very difficult to visualise many of these bony structures on radiographs.

The anatomy of the skull, including both the cranial and facial bones, is very detailed, especially those crania bones making up the "floor" and lower "walls" of the cranial vault. To visualise many of these structures requires controlled use of displacement radiography. This requires either certain rather precise angulations of the central ray or specific obliques of the skull. An example of this is an axial AP projection of the skull which specifically demonstrates the occipital bone and the petrous pyramids of the temporal bone. This projection requires a very precise 30 degree caudal angle to the orbitomeatal line, a special positioning line of the head. This central ray angulation projects the facial bone mass caudally so it will not superimpose the specific structures being demonstrated on this projection. The same is true for visualising the facial bones without superimposition by the dense petrous pyramids.

Good skull radiography is a definite challenge and requires much effort and study before it can be mastered. The detailed anatomy of the skull is presented in such a way in the textbook that it will allow you to learn the anatomical terms for all of these structures as well as relationships to other internal as well as external structures and landmarks.

2. LEARNING OUTCOMES

After you have successfully completed all the activities, you will be able to:

2.1 List and locate all surface landmarks and localising lines described in this theme.

2.2 Identify the external landmarks, which correspond to the level of the floor of the anterior cranium and the level of the petrous ridge.

2.3 List the eight cranial bones and identify the four bones composing the calvarium or "skull cap" and the four making up the "floor" of the cranium.

2.4 Describe the relative locations or positions of the eight cranial bones and identify on drawings and radiographs the various portions or parts of each cranial bone as described in this theme.

2.5 List and identify on drawings and radiographs the sutures of the skull including the areas of the six fontanels or "soft spots" on newborns.

2.6 List the number and the names of specific adjoining cranial bones with which each cranial bone articulates.

2.7 List the three terms describing the common shape classifications of the cranium and identify the approximate angles of the petrous pyramids for each classification.

2.8 Describe the correct angle (caudal or cephalic), the degrees of angle and the line used to determine this angle on a PA Caldwell, and an axial AP projection.

2.9 For a submentovertex projection, identify the line, which should be as near parallel to the plane of the film as possible and describe the relationship of the central ray to this line.

2.10 Position a model and/or phantom for each of the basic and optional projections as described in the textbook. Include the three different ways for taking each projection which are:

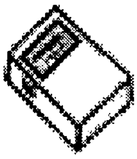
(a) on a routine radiographic table;

(b) on a vertical head unit or erect table or grid film holder;

(c) modifications for severely injured patients.

2.11 Critique skull radiographs based on evaluation criteria provided in the textbook.

2.12 Discriminate between radiographs which are acceptable and those which are unacceptable due to exposure factors, collimation or positioning errors.



3. SOURCES

Bontrager, K.L. 1993. *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual.* Vol. 1, 3rd ed. U.S.A: St Louis. Mosby. 217-268.

Bontrager, K.L. 1997. *Radiographic Positioning and Related Anatomy.* 4th ed. U.S.A., St Louis: Mosby. 323-358.

Ballinger, P.W. & Frank, E.D. 1999. *Merrill's Atlas of Radiographic Positions and Radiiiologic Procedures.* 9th ed. U.S.A., St Louis: Mosby. 231-307.

4. ACTIVITIES

Activity 1

Topographical Anatomy and Landmarks, Lines and Planes of the skull.

The following review exercises should be completed only after careful study of the associated pages in the textbook.

1. Fill in the total number of bones for:
   - A. Cranium ____
   - B. Facial bones ____
2. Describe the location of the following topographical landmarks of the cranium:
   - A. Glabella ____
   - B. Acanthion ____
   - C. Mental point ____
   - D. Superciliary ridge (arch) ______________________________
   - E. Supraorbital groove ________________________________
   - F. Nasion ____
   - G. Angle (gonion) ____________________________________
   - H. Vertex ____
   - I. Inion ____ .
3. Which of the above landmarks corresponds to the level of the floor of the anterior fossa of the cranium?

   ______________________________ .

4. Fill in the correct term describing the following five landmarks relating to the eye or rim of orbit:
   - A. Medial junction of two eyelids ______________________
   - B. Lateral junction of the two eyelids____________________
   - C. Superior rim of orbit ______________________________

D. Inferior rim of orbit ______________________________

E. Lateral aspect of orbital rim________________________ .

5. Fill in the correct term or a second term for the following landmarks:

A. EAM ____________________________

B. TEA ____________________________

C. SOM____________________________

D. IOM ____________________________ .

6. The orbit is (a) ___________ in shape and extends (b)_____________ (anteriorly or posteriorly) from the base.

7. The circular rim of the orbit, which can be palpated, is actually the________________ of the orbit.

8. What is the external landmark corresponding to the petrous ridge?

____

9. Fill in the correct term describing the following planes and lines:

A. Divides the body into right and left halves ______________

B. Describes the imaginary line drawn between the pupils of the eyes ______________

C. The line connecting the glabella to the EAM ____________

D. The line connecting the outer canthus of the eye to the EAM

____

E. Describes the line between me infraorbital margin and the EAM _______________________

F. The line between the acanthion and the EAM ___________

G. The line between the "chin" and the EAM ______________

H. The line between the glabella and the anterior aspect of the alveolar process of the maxilla ____________________ .

10. Reid's base line, or just base line is also used occasionally to describe the _______________________________________ .

11. Which line should be perpendicular to the film on a true lateral skull? ____

12. Which body plane of the head must be parallel to the plane of the film on a true lateral skull? ______________________________

Activity 2

Anatomy of the skull

1. What is the correct anatomical term describing the skull cap? (a)___________________
   What are the names of the four bones making up this portion of the skull? (b)______________right and left (c)____________ and (d)____________________________.
2. What are the names of the additional four cranial bones which primarily make up the floor of the cranium? The right and left (a)____________, the (b)__________, and the (c)__________.
3. The frontal bone can be divided into two portions, the vertical or (a)______________ portion and the horizontal or (b)______________ portion.
4. The ridge of bone under each eyebrow is called the ______________________.
5. The portion of the frontal bone forming the superior aspect of each orbit is the ______________.
6. Two bones which primarily make up the walls of the calvarium or skull cap are the right and left ____________________ .
7. The widest portion of the skull is found between the _____________________ of the two bones described in question number 6.
8. Answer the following questions on the joints or articulations of the skull (excluding the temporomandibular joint, TMJ):
   A. The correct anatomical term for these joints? ______________
   B. Structural classification of these joints? __________________
   C. Functional or mobility classification of these joints? ________
   D. Are these movable or immovable joints? _________________
   E. Separates the frontal from the two parietals. _______________
   F. Separates the two parietals. ___________________________
   G. Separates the two parietals from the occipital bone. ________

H. Separates the parietals from the temporals. ______________

I. The anterior end of the sagittal suture is called the _______ .

J. The posterior end of the sagittal suture is called the _______ .

K. The areas described in Parts I and J are "soft spots" in new borne and are called the anterior and posterior ____________________.

L. The "soft spots" located at the sphenoid angle of the parietal bone on each side of the head are called (a)____________________, on an adult this point (which can be used for specific cranial measurements) is called the (b)_____________.

M. The second lateral "soft spot" located at the mastoid angle of the parietal bone on each side is called the (a)_____________and on an adult is called the (b)__________.

N Which of die six "soft spots" of the cranium is the largest and doesn't close until about 18 months of age? ____________________

O. What are the small irregular bones called which sometimes develop in adults at the "soft spots?" ____________________

9. The posterior and somewhat inferior portion of the calvarium is formed by the single ____________________ bone.

10. The large hole or opening in the bone described in question 9 is called the ________________.

11. The two oval convex articular surfaces on each side of this large opening at the base of the skull are called (a)________________ or (b)____________________________.

12. The articulation between the skull and cervical spine is called the ______________joint.

13. Identify the labelled parts of the following drawings:

A. ______________________

B. ______________________

C. ______________________

D. ______________________

E. ______________________

F. ______________________

G. ______________________

H. ______________________

I. ______________________

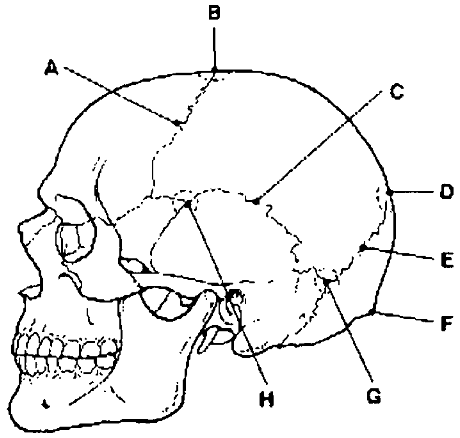
J. ______________________

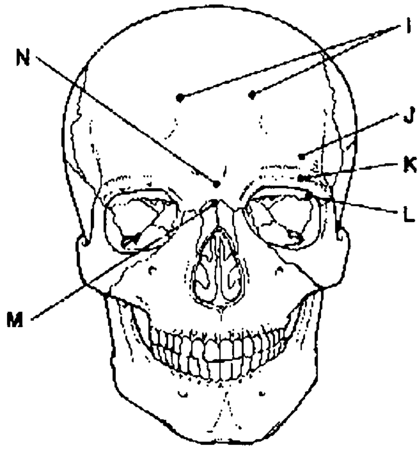
K. ______________________

L. ______________________

M. ______________________

N ______________________





14. The two lateral condylar processes are part of the ______________________ bone. (Hint: these processes help make up a joint involving the skull.)

15. The ___________ bones house the organs of hearing and balance.

16. The ___bone is the primary anchor bone for all eight cranial bones.

17. The___________ bone lies primarily below the floor of the cranium.

18. The thin "wall" portion of the temporals is called the ___________ portion (similar to name of the suture at upper border of temporal).

19. The temporal bone contains a process of bone called the (a) _____ process, which meets another process of a facial bone to make up a prominent arch of bone called the (b) __________________.

20. The temporal bone contains a fossa called the ______________ fossa, which helps form the only diarthrodial, or freely movable joint of the skull.

21. A slender process of the temporal bone projecting downward is called the ______________ process.

22. The thick portion of the temporal bone directly posterior to the EAM which contains air cells is called the (a)__________ portion, which has a small, somewhat "blunt" process or tip projecting downward called the (b) _______________.

23. The petrous portions of the temporal bones are the thickest and most dense bones in the skull and are sometimes also called the (a)____________or __________. The upper edges of these portions are often called the (b) ________________.

24. The central depression of the sphenoid which looks like a saddle is called the (a)_______________which protects the important (b)__________________ gland.

25. The back of this "saddle" is called the (a) _______________, which contains two small ear-like projections of bone called the (b) ______________________.

26. The two small, ear-like projections anterior to the "saddle" are called the (a) _______ , which are attached to a pair of triangular shaped and nearly horizontal projections of the sphenoid called the (b) _________________ .

27. The shallow depression just posterior to the dorsum sellae, which forms a continuous groove to the foramen magnum and provides a base of support for the pons portion of the brain, is called the ____________.

28. The sphenoid bone contains four processes projecting downward:
    A. The two more lateral and somewhat flat processes are called _____________.
    B. The two medial and more pointed processes are called the ______________.
    C. The two hook-like projections extending from the medial processes are called the __________.

29. The three pairs of small openings (for nerves and blood vessels) in the greater wing of the sphenoid are the (a) ________________, (b) ________________ and (c) ____________.

30. The sphenoid articulates with ______________other cranial bones.

31. Answer the following questions regarding the ethmoid bone:

A. The small horizontal portion located in the ethmoid notch of the frontal bone is the ______________________.

B. The superior projection, which has an appearance of a rooster's comb, is the ______________________.

C. The portion projecting downward in the midline to help form the bony nasal septum is the ____________________.

D. The two lateral masses, also called the lateral_____________, contain air cells and are suspended inferiorly from the undersurface of the horizontal portion of the ethmoid.

E. Extending medially and downward from these lateral masses are thin, scroll-like projections called the superior and middle (a)_______________, sometimes called (b)________________.

F. The ethmoid articulates with two cranial bones, the (a)__________and (b) _________.

32. Full in the following from the labelled drawings:

A. ________________________

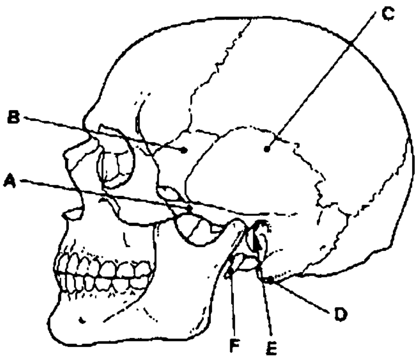
B. ________________________

C. ________________________

D. ________________________

E. ________________________

F. ________________________



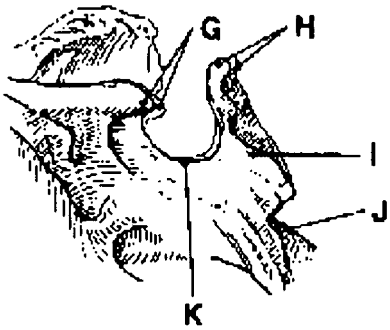
G. ________________________

H. ________________________

I. ________________________

J. ________________________

K. ________________________



L. ____________________

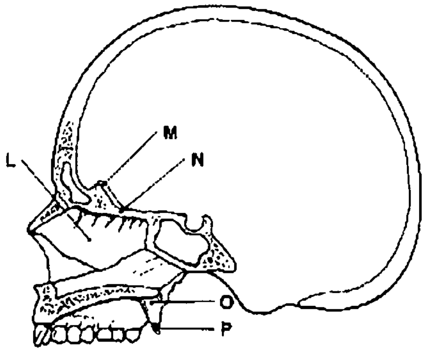
M. ____________________

N. ____________________

O. ____________________

P. ____________________

Q. ____________________



R. ____________________

S. ____________________

T. ____________________

U. ____________________

V. ____________________

W. ____________________

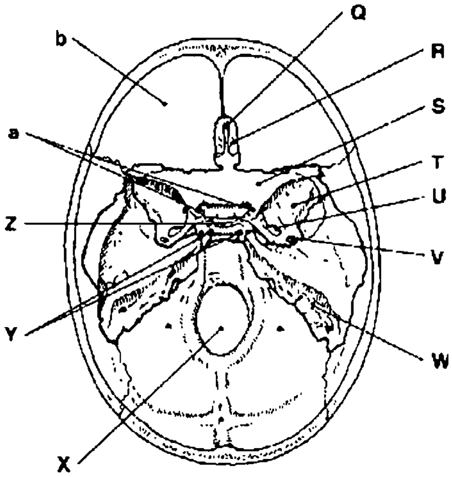
X. ____________________

Y. ____________________

Z. ____________________

a. ________________

b. ________________



33. The frontal bone articulates with four cranial bones, the right and left (a)__________, the (b)______________ and the (c)__________.

34. The parietal articulates with five cranial bones: (a) ______, (b) ______, (c) ________, (d)___________, and (e)______________ .

35. The occipital articulates with six bones: right and left (a) ___________, right and left (b) _________, the (c) ________, and the (d)________ .

36. A lateral measurement of the cranium should be made in the area of the largest diameter which is between the two (a)________________, which averages b)______centimetres.

37. The antero-posterior measurement should be made between the (a)________________ and the (b)____________________, which averages (c)_____centimetres.

38. Fill in the correct shape classifications and the approximate angle between the petrous pyramids and the midsagittal plane for the following:

    A. Average shaped head ______________, _________degrees

    B. Short broad head __________________, _________degrees

    C. Long narrow head _________________, _________degrees

Activity 3

Positioning of the Cranium and Sella Turcica

1. List the three basic and the one optional projection most commonly included in a skull series. List second terms where more than one term is commonly used.

   Basic: A. ______________________________

   B. ______________________________

   C. ______________________________

   Optional: D. ______________________________

2. When positioning for a lateral skull projection, which line should be placed perpendicular to the side of the table? ______________________________

3. Indicate which way the 24 x 30 cassette should be placed (crosswise or lengthwise) on the following projections taken on a radiographic table:

    A. Lateral ________________________

    B. PA or Caldwell ______________________

    C. AP axial ______________________

    D. Submentovertex ______________________

4. What are the two lines, which snould be checked carefully to insure a true lateral skull position? Indicate if these should be parallel or perpendicular to the plane of the film.

    A. ___________________ ____________________

    B. ___________________ ____________________

5. Describe the central ray location for the following two methods commonly used in centring for a lateral skull projection.

   Centre entire cranium to film: ________________________

   Centre sella turcica to film: ________________________

6. There is a ___ degree difference between the OML and the IOML.

7. In checking a lateral skull radiograph for possible rotation or tilt, what four pairs of anatomical structures should be directly superimposed?

   A.__________ C.____________ B.___________ D.____________

8. Fill in the correct lines and/or planes, which should be perpendicular to the film on the following positions or projections:

   A. Lateral: ___________ line

   B. PA Caldwell: (a) _____________ line and (b) __________plane

   C. AP axial: (a) ____________ line and (b) _____________plane

9. Fill in the correct angle, number of degrees and the correct line used to determine this angle on the following:

	Caud./Ceph	Angle	Line
A. PA Caldwell	(a)	(b)	(c)
B. Reversal of Caldwell-trauma	(a)	(b)	(c)
C. AP axial	(a)	(b)	(c)

10. For an AP axial projection, the central ray should be angled (a)____degrees caudal if the orbitomeatal line is perpendicular to the film and (b)____degrees if the infra-orbitomeatal line is perpendicular.

11. The dorsum sellae and posterior clinoids are projected into the foramen magnum on which sella turcica projection(s)? __________

12. The dorsum sellae and posterior clinoids are projected just superior to the foramen magnum, superimposing the occipital bone, with the ______________ sella turcica projection.

13. What two intracranial structures are demonstrated in profile on a true lateral skull? (a)_____________ and (b) _________________.

14. Complete the following for a submentovertex projection of the skull:

A. The patient should be positioned so the _____line is parallel to the plane of the film.

B. The central ray must be perpendicular to the _________line.

C. If the correct line was perpendicular to the central ray, then the condyles of the mandible will be projected (a)__________(anterior or posterior) to the (b)___________.

15. The projections best demonstrating the following:

A. Sella Turcica (a)__________and (b)__________________.

B. Petrous Pyramids (ridges) (a)___________ and (b) ______.

16. The internal auditory canals are best demonstrated on which projection? _________________

17. Which trauma skull projection is essential for visualising inner cranial air/fluid levels? ___________________

Radiographic positioning laboratory exercises

For this section you need another person or an articulated phantom to act as your patient. Practise the following until you can do each of them accurately and without hesitation. It is important to achieve both accuracy and speed in radiographic positioning. Include the following parameters as you simulate the basic positions or projections listed:

- correct choice of source image receptor distance
- correct size and type of film holder
- correct location of central ray
- correct centring of part to film
- correct placement of R and L markers
- accurate collimation
- proper use of immobilising devices when needed
- proper use of positioning aids as needed
- approximate correct exposure factors
- correct instructions to your patient before and during exposure.

1. Table top lateral and PA Caldwell projections.
2. Table top AP axial and submentovertex projections.
3. Erect (with head unit if available or with erect table or other erect grid-film holder), lateral, PA Caldwell, AP axial and submentovertex projections.
4. Severely injured patient who cannot be moved from a supine position on a stretcher. (A cross-table lateral cervical spine has ruled out spinal injury.) Take a cross-table lateral projection, AP projection to replace routine PA Caldwell and AP axial (Towne) projection.
5. Special projections for sella turcica (erect or table top).
6. Cross-table lateral projection.
7. AP Axial (Towne) and modified AP to replace PA Caldwell on severely injured patient.
8. Tabletop lateral and PA Caldwell projections.
9. Submentovertex projection (disarticulated skull phantom only).

REFERENCES

Bontrager, K.L. 1993. *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual.* Vol. 1, 3rd ed. U.S.A: St Louis. Mosby. 217-268.

Bontrager, K.L. 1997. *Radiographic Positioning and Related Anatomy.* 4th ed. U.S.A., St Louis: Mosby. 323-358.

Ballinger, P.W. & Frank, E.D. 1999. *Merrill's Atlas of Radiographic Positions and Radiiiologic Procedures.* 9th ed. U.S.A., St Louis: Mosby. 231-307.

APPENDIX VIII

Study group III: Self-study

APPENDIX VIII

STUDY GROUP III: SELF-STUDY

SKULL

LEARNING OUTCOMES

- List and locate all surface landmarks and localising lines described in this theme.
- Identify the external landmarks, which correspond to the level of the floor of the anterior cranium and the level of the petrous ridge.
- List the eight cranial bones and identify the four bones composing the calvarium or "skull cap" and the four making up the "floor" of the cranium.
- Describe the relative locations or positions of the eight cranial bones and identify on drawings and radiographs the various portions or parts of each cranial bone as described in this theme.
- List and identify on drawings and radiographs the sutures of the skull including the areas of the six fontanels or "soft spots" on newborns.
- List the number and the names of specific adjoining cranial bones with which each cranial bone articulates.

- List the three terms describing the common shape classifications of the cranium and identify the approximate angles of the petrous pyramids for each classification.

- Describe the correct angle (caudal or cephalad), the degrees of angle and the line used to determine this angle on a PA Caldwell, and an axial AP projection.

- For a submentovertex projection, identify the line, which should be as near parallel to the plane of the film as possible and describe the relationship of the central ray to this line.

- Position a model and/or phantom for each of the basic and optional projections as described in the textbook. Include the three different ways for taking each projection which are:
  - ✓ on a routine radiographic table;
  - ✓ on a vertical head unit or erect table or grid film holder;
  - ✓ modifications for severely injured patients.

- Critique skull radiographs based on evaluation criteria provided in the textbook.

- Discriminate between radiographs, which are acceptable, and those, which are unacceptable due to exposure factors, collimation or positioning errors.

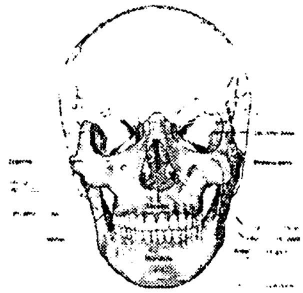
C. INTERVENTION

APPENDIX IX

Interactive lecture

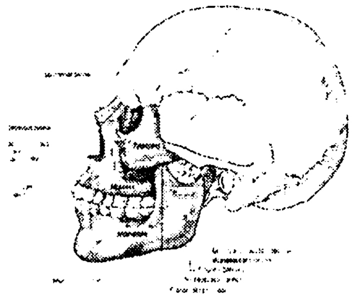
Figures and radiographs from *Merrill's Atlas of Radiographic Positions and Radiologic Procedures* (Ballinger & Frank 1999:309) and *Radiographic Positioning and Related Anatomy* (Bontrager 1997:359).

Facial Bones

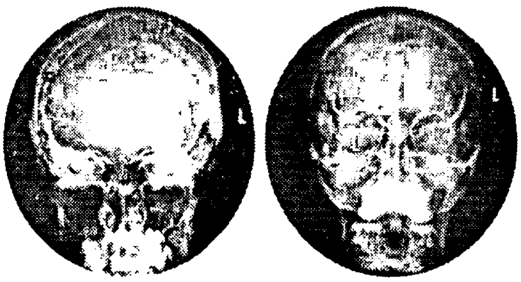


Figures and Radiographs courtesy of Ballinger & Frank Merrills Atlas of Radiographic Positions and Radiologic Procedures and Bontrager Radiographic Positioning and Related Anatomy.

Facial Bones



Projections



OML vs. MML Erect vs. Supine AP vs. PA

Lateral Facial bone

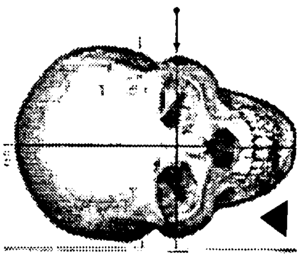
Structures

- Facial bones
- Wings of sphenoid
- Sella turcica
- Zygoma
- Mandible

Lateral Facial bones

Part position

- Side of interest
- True lateral
- Nasion=Occ.prot.
- No rotation/tilt
- MSP//
- Interpupilary
- CR ½ outer canthus EAM (Zygoma)



Evaluation criteria

- Zygomas
- No rotation & tilt
- Mandibular Rami, EAM
  orbital roofs
  Sella turcica
- Maxillary region

Parietoacanthial

Structures
- Inferior orbital rim
- Zygomatic bones
- Zygomatic arches
- Nasal Septum
- Maxillae
- Anterior nasal spine

Parietoacanthial

Part position.
- Chin
- MML
- OML = 37⁰
- No rotation/No tilt
- MSP ⊥
- CR ⊥ Acanthion


Acanthion

Evaluation criteria

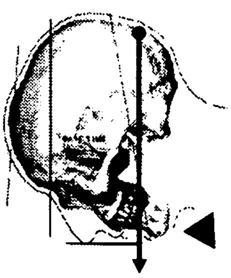
- Inferior Orbital Rim
- Petrous ridge ⇩ Maxillary sinuses
- Entire skull
- No rotation: septum=skull margin
- Inferior Max.sin. free from alveolar processes

Mod. Parietoacanthial

Structures
- Orbital floors & Rims
- Zygomatic bones
- Zygomatic arches
- Nasal Septum
- Maxillae
- Ant. nasal spine

Mod. Parietoacanthial

Part position
- Nose & Chin
- LML ⊥
- OML = 55⁰
- No rotation/tilt
- MSP ⊥
- CR ⊥ Acanthion


Acanthion

Evaluation criteria

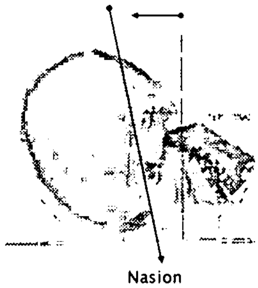
- Inf. Orb. Rim film ⊕
- Petrous ridge ⇩ ½ Maxillary sinuses
- Entire skull
- ✎ orbital floors
- No rotation-Nasal septum = orbital margin

PA axial 15^0 (Caldwell)

Structures
- Maxillae
- Nasal Septum
- Zygomatic bones
- Ant. Nasal spine
- 30^0 - Orbital rim

PA axial (Caldwell)

Part position
- Nose & forehead
- OML ⇔
- No rotation/ tilt
- MSP ⇔
- Cassette ⊕ nasion
- CR 15^0 ext nasion



Evaluation criteria

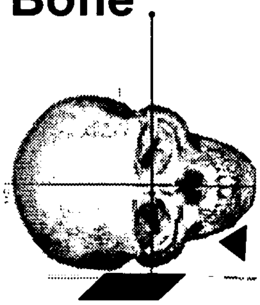
- No rotation-Crista galli=skull margin
- Petrous ridge lower 1/3 orbit
- Frontal sinus ⇧ Fronto-nasal suture
- Sup. Orb. Fiss. Orbits =

Nasal Bones R+L

Structures
- Nasal bone
- Soft tissue

Nasal Bone

Part position
- Side of interest
- True lateral
- Nasion=Occ.prot.
- No rotation/tilt
- MSP//
- Interpupilary ⇔
- CR 1.25cm ⇩ nasion



Evaluation criteria

- Nasal bone ⊕
- No rotation
- ↯ Nasal bone & soft tissue

Nasal Supero-inferior

Structures

- Nasal bone
- Soft tissue

Nasal Supero-inferior

Part position

- Chin
- GAL ⊥ film
- OML = 37°
- No rotation/No tilt
- MSP
- CR ⊥ GAL (skim)

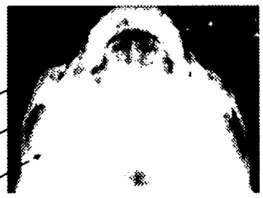
Evaluation criteria

- Nasal bone ⊕
- No rotation
- Nasal bone & soft tissue
- Glabella & alveolar line not over nasal septum

Zygomatic arches SMV

Structures

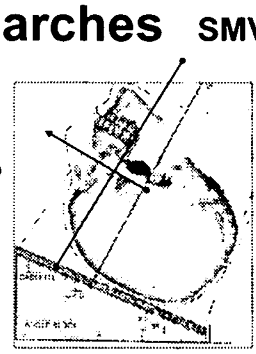
- Bilateral zygomatic arches



Zygomatic arches SMV

Part position

- Hyper extension
- Glabelle=Occ.protub
- No rotation/tilt
- MSP ⊥
- IOML //
- CR 4cm ⇩ Mand. symph. & ½ Zygomatic arches



Evaluation criteria

Entire skull

No rotation & tilt

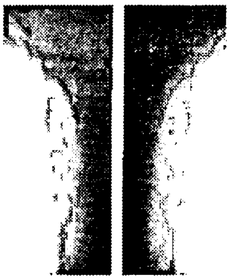
- Zygomatic arches lateral of zygomatic & temporal bones
- Mand. Symph. superimposes ant. frontal bone
- Zygomatic arches symmetrically

Zygomatic arches

Obl. Inferosuperior (Tangential)

Structures

- Single zygomatic arch
- Trauma -Flat or depressed



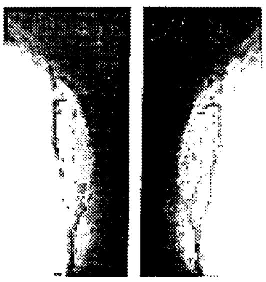
Zygomatic arches

Part position

- Hyper extension
- Rotate head 15^0
- Tilt head 15^0
- IOML ⇔
- CR⇔to IOML
- ⊕ to Zygomatic arch of interest

Evaluation criteria

- Zygomatic arch ⊕
- ↯ zygomatic arch
- Zygomatic arches without superimposition of parietal or mandible



Zygomatic arches

AP axial 30^0 (Modified Towne)

Structures

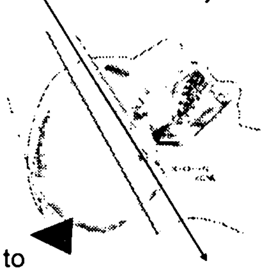
- Bilateral Zygomatic arches

Zygomatic arches

AP axial 30^0 (Modified Towne)

Part position

- OML ⇔
- No rotation/tilt
- MSP⇔
- CR 30^0 caudad to OML or
- 37^0 to IOML
- ⊕ 2.5 cm superior to Glabella



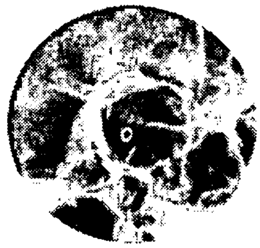
Zygomatic arches

AP axial 300 (Modified Towne)

- Zygomatic arch ⊕
- ↯ zygomatic arch
- Zygomatic arches ✣mandible
- Zygomatic arches symmetrical

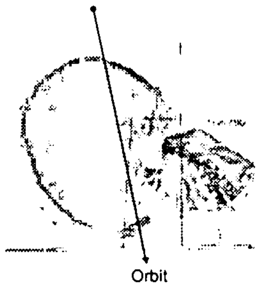
Parieto-Orbital (Rhese)

Structures
- Cross section of each optic canal
- Non-distorted view of optic foramen



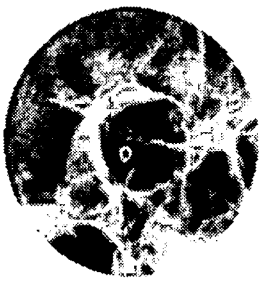
Parieto-Orbital (Rhese)

Part position
- Nose chin & cheek
- MSP 53^0 angle
- AML ⇔
- CR to ⊕ downside orbit
- CR to film downside orbit



Evaluation criteria

- Optic foramen ⊕ lower outer quadrant of orbit
- Optic foramen to collimated field
- Orbital margins in collimated field
- ⚡ Visualise optic foramen

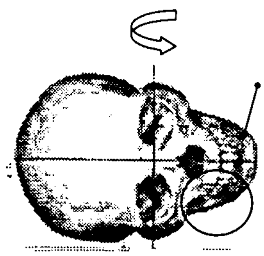


Axiolateral Mandible

Structures
- Mandible rami
- Body & mentum

Axiolateral Mandible

Part position
- Side of interest ⇒
- True lateral
  -ramus 30^0
  -body 45^0
  -mentum 10-15^0
  general survey
- CR 25^0 cephalad
- CR pass through mandible



Evaluation criteria

- Mandible ⊕
- Opposite mand. not over ramus
- Ramus free of Cerv.sp.
- Condylar and coronoid visualizes
- ⚡ visualize mandibular area of interest

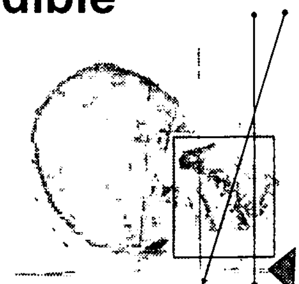
PA/PA Axial

Structures
- PA
- Mandibular rami
- Lateral portion of body
- PA Axial
- Proximal rami
- Lateral aspects of body
- Elongated view of condyloid processes

Mandible

PA/PA Axial

Part position
- Forehead & Nose
- OML
- MSP
- PA-CR exit -lips
- PA Axial 20-25^{0} exit-Acanthion



Evaluation criteria

- Include TMJs'
- Mandible without rotation-mand.rami=Cs
- Midbody & mentum=Cs
- PA Axial TMJ & condyles visible through mastoids
- Condyloid processes well visualize

Mandible

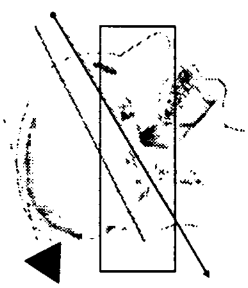
AP axial 30^{0} (Towne)

Structures
- Condyloid processes of mandible
- Temporo mandibular fossae

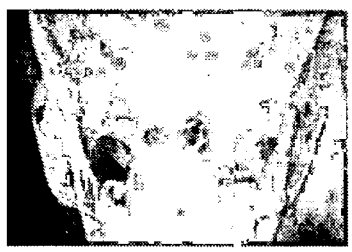
Zygomatic arches

AP axial 35^{0}
(Modified Towne)

Part position
- •OML
- •No rotation/tilt
- •MSP
- •CR 35^{0} caudad to OML/37^{0} to IOML
- ⊕to Glabella ½ EAM

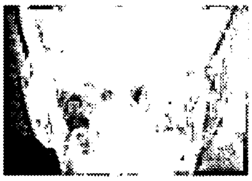


Zygomatic arches



Evaluation criteria

- Condyloid processes symmetric
- TM fossae
  visualise zygomatic arch
- TM fossa mastoids
- Condyloid processes &
  TM fossae visible



Zygomatic arches

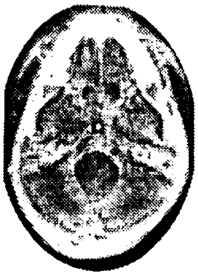
Part position

- Prone
- Nose & chin on film
- MSP
- 23-38^0 caudal
- Enter vertex
- ½ Zygomatic arches

Mandible SMV

Structures

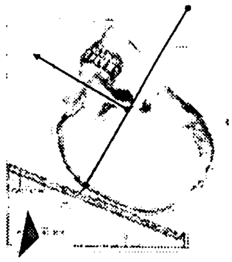
- Entire Mandible
- Coronoid
- Condyloid processes



Mandible SMV

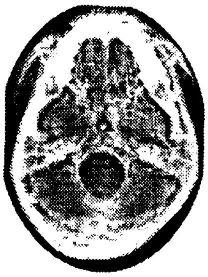
Part position

- Hyper extension
- IOML//
- No rotation/tilt
- MSP
- CR $^{1/2}$L^e of mandible
- CP 4cm inf. to mand.symph.
- CR IOML



Evaluation criteria

- Entire Mandible
- No rotation/tilt
- Condyles anterior to petrous ridges
- Mand. Symph. frontal bone
- Mandibubal=border
- Mandibular coronoid processes lateral from rami



Additional

- PA Oblique
- Panorex

- Inferiorsuperior-
  Intra-oral (45^0)

TMJs

AP axial 30^0

(Modified Towne)

Structures

- •Condyloid processes
- •TM fossa

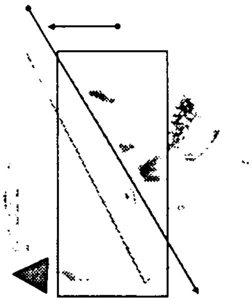
TMJs

AP axial 20^0

(Modified Towne)

Part position

- OML ⇧
- No rotation/tilt
- MSP ⇧
- CR 20^0 caudad to OML/42^0 to IOML
- ⊕ TMJ



Evaluation criteria

- Condyloid processes & TM fossa
- Mandible - no rotation

Axiolateral TMJs

Structures

- TMJ closest to film
- Bilateral ✣
- Open & closed mouth

Axiolateral TMJs

Part position

- Side of interest
- Nasion=Occ.prot.
- No rotation/tilt
- MSP //
- Interpupilary ⇧
- CR 25-30^0 caudad
- CP 1,3 ant & 5cm sup. of EAM

Schuller Method

Evaluation criteria

- TMJ ⊕ to film
- TMJ anterior to EAM
- Open & closed
- no motion
-  visualise TMJ

Bontrager, K.L. 1993. *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual.* Vol. 1, 3rd ed. U.S.A: St Louis. Mosby. 217-268.

Bontrager, K.L. 1997. *Radiographic Positioning and Related Anatomy.* 4th ed. U.S.A., St Louis: Mosby. 323-358.

Ballinger, P.W. & Frank, E.D. 1999. *Merrill's Atlas of Radiographic Positions and Radiologic Procedures.* 9th ed. U.S.A., St Louis: Mosby. 231-307.

APPENDIX X

Interactive learning guide

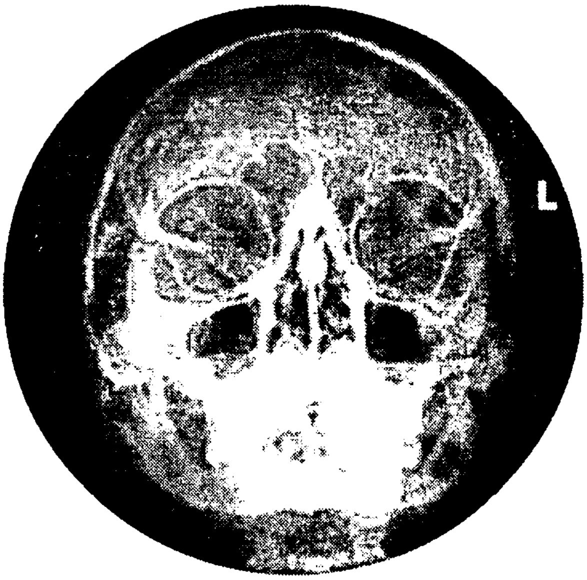
Activities from *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual*. Vol. 1, 3rd ed. (Bontrager 1993:261-266).

APPENDIX X

INTERACTIVE LEARNING GUIDE

School of Health Technology
RADIOGRAPHY
Technikon Free State

Learning Guide



Radiographic Practice RAD 20 at
Theme: Facial Bones 3 credits
May 2002

S.M. Brüssow

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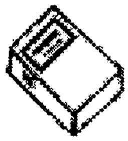
Unit I

Bontrager p. 341 / Merril p. 292



FACIAL BONES

1. INTRODUCTION

Radiography of the facial bones requires a good understanding of the anatomy of these 14 separate bones. The facial skeleton is difficult to radiograph, not only because of the complexity of these bones, but also because they are situated directly anterior to very dense cranial structures. For example, how could the maxillary bones comprising the upper jaw be visualised on a frontal projection, since the very dense petrous pyramids are located posteriorly and at the same level as these bones? A certain tilt of the head will cause the facial bones to be thrown up just enough so they will be projected on the radiograph slightly higher than the petrous pyramids. Thus it is especially important that you not only know the specific anatomy of the facial bones, but also know the relative positions of each specific part of these bones in relationship to other cranial structures.

The orbits or bony cavities of the eye sockets contain small openings for nerves and blood vessels and certain types of pathology or abnormalities involving these openings or foramina can only be diagnosed on radiographs. This again requires a thorough understanding of the shape and structure of the bony orbits in order to be able to direct the central ray precisely through these foramina to visualise them on film. On patients these skeletal structures are covered with skin and other tissues and you must learn and understand this anatomy to the extent that you develop "x-ray sight" and know and be able to "see" and locate these skeletal structures.

It is also very difficult to recognise specific facial and cranial anatomy on radiographs because they often superimpose each other. Even many experienced technologists have difficulty with this. You should take special note of the labelled radiographs in this chapter and learn to look for certain more obvious structures and relate other less obvious structures to them. This will require that you study actual radiographs, which are not labelled in the lab and identify all structures identified on the radiographs in the textbook. You will also need to practise each projection and position described in this chapter and evaluate resultant radiographs for proper patient positioning, technical factors, and the visualisation of specific needed anatomy.

2. LEARNING OUTCOMES

After you have successfully completed all the activities you will be able to:

1. List the 14 facial bones (with correct spelling).
2. Identify both on drawings and radiographs, anatomical parts of each facial bone as defined in the textbook.
3. Identify the two anatomical names for the "cheek" bone.
4. List the names of specific cranial and facial bones with which each facial bone articulates.
5. Identify the temporomandibular joints (on radiographs) and discriminate between those taken in the open mouth position and those taken in a closed mouth position.
6. Describe the shape and the position of the bony orbits within the skull. Identify the angle formed between the cone-shaped orbits and

the orbitomeatal line and between the cone-shaped orbits and the midsagittal plane.

7. List the seven bones making up the orbits and identify which are facial bones and which are cranial bones.
8. Identify on a dry skull each of the seven bones comprising the orbits as well as the three openings of the orbits.
9. List the two basic projections or positions for a routine facial bone series and the optional position for the "floor" of the orbits.
10. Describe the difference between the routine Waters and the modified Waters positions and describes what anatomical structures are best demonstrated on each.
11. List the two basic projections or positions taken for a routine zygomatic arch series and the three optional positions or projections.
12. List the two basic projections or positions for a routine mandible series. Describe the differences in positioning for the axiolateral to best visualise the ramus, the body, or the mentum.
13. List the optional projections or positions, which best demonstrate the following specific parts of the mandible: (1) the upper rami and condyloid processes; (2) the mentum; and (3) the u-shaped outline of the body and mentum.
14. List the two possible projections for the visualisation of the temporomandibular joints and identify the reason for preceding TMJ radiography with routine mandible radiographs. Identify the reason for examining the TMJs bilaterally and in both the open and closed mouth positions.
15. Identify the special position commonly used to demonstrate the optic foramen. Describe the positioning line, which must be parallel to the central ray, and the degrees of angle between the midsagittal plane and the tabletop.
16. Position on a model and/or phantom each of the basic and optional projections as described in the textbook. Include the three different

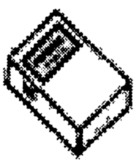
methods for taking each projection which are: (a) on a routine radiographic table; (b) on a vertical head unit or erect table or grid film holder; and (c) modifications for severely injured patients.

17. Critique assorted facial, mandible, and orbital radiographs based on evaluation criteria provided in the textbook.
18. Discriminate between radiographs which are acceptable and those, which are unacceptable due to exposure factors, collimation or positioning errors.

Prerequisite

An understanding of the surface landmarks and the localising lines as described in the skull guide, as well as the anatomy and positioning of the cranium is essential prior to beginning this theme on the facial bones.

3. SOURCES



Bontrager, K.L. 1993. *Radiographic Positioning and Related Anatomy: Workbook and Laboratory Manual.* Vol. 1, 3rd ed. U.S.A: St Louis. Mosby. 217-268.

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Ballinger, P.W. & Frank, E.D. 1999. *Merrill's Atlas of Radiographic Positions and Radiiiologic Procedures.* 9th ed. U.S.A., St Louis: Mosby. 231-307.

4. THEME OUTLAY

At the beginning of this theme I would like to provide you with a bird's eye view in the form of a summative chart

Radiographic Anatomy

↓

Facial bones (14)

↓

Maxillae
Zygoma
Lacrimal
Nasal
Inf cinchae
Palatine
Vomer
Mandible

↓

Basic and Special Projections

Facial Bones
Basic
Lateral
Parietoacanthial (Waters)
PA (Caldwell)
Special
Modified Parieto-Acanthial
(Modified Waters)

Nasal Bones
Basic
Lateral
Parietoacanthial (Waters)
Special
PA (Caldwell)
Superoinferior (axial)

Zygomatic arches
Basic
SMV
Obl. Inf.Sup (Tangential)
AP axial (Mod.Towne)
Special
Parietoacanthial (Waters)
Lateral

Optic Foramina
Basic
Rhese
Waters
PA (Caldwell)
Special
Parietoacanthial
(Modified Waters)

Orbits
Basic
M. Parietoacanthial
Modified Waters

Mandible
Basic
Axiolateral
Cross table
(trauma)
PA 0^0 & $20\text{-}25^0$ caphalad
AP axial (Towne)
Special
SMV / *Panorex*

TMJs
Basic
AP axial (M.Towne)
Special
Axiolateral 15^0obl.
Axiolateral
Tomography

It will take you about 60 minutes to complete Activity 5.

5. ACTIVITIES

PART I RADIOGRAPHIC ANATOMY

LINK! Specified learning outcomes 2.3
Learning outcomes 1-8

Review Exercise A

Anatomy of Facial, Nasal, Mandibular, and Orbital Bones

1. List all of the facial bones and indicate if they are single or paired bones.

	Facial bones	Single or paired
A.	______________________	__________________
B.	______________________	__________________
C.	______________________	__________________
D.	______________________	__________________
E.	______________________	__________________
F.	______________________	__________________
G.	______________________	__________________
H.	______________________	__________________

2. Complete the following:
   - A. A second anatomical name for the zygomatic bone is _____ .
   - B. The largest facial bone is the __________ .
   - C. The largest immovable facial bone is the
   - D. Which facial bone assists in forming the mouth, nose, and orbital cavities? ________________
   - E. The inferior aspect of the body of the maxilla is called the _______________ .
   - F. The pointed process of the maxilla located at the acanthion is called the _____________ .

G. The parts of the maxilla, which help form the roof of the mouth, are the right and left __________ .

3. Each maxilla articulates with two cranial bones, (a) ___________ and (b) ____________ .

4. List the four separate facial bones, which make up the hard palate:

   A. ____________________ C. ____________________

   B. ____________________ D. ____________________

5. The zygomatic arch is formed by the (a) ______________ and (b) __________ bones.

6. The zygomatic prominence is a positioning landmark and refers to the most prominent portion of the________________ bone.

7. Each nasal bone articulates with which two cranial bones?

   A. _________________

   B. _________________

8. The pair of small facial bones closely associated with the tear ducts is the _____________.

9. An incomplete joining of the two palatine processes of the maxillae results in a condition called _____________ .

10. The upper teeth are embedded in cavities along the inferior edge of the (a) ___ process of the (b) ______________ bones.

11. The large air-filled cavities located in the body of the maxillary bones are called ____________________ .

12. The ____________ process of each maxilla projects upward along the lateral border of the nose.

13. The surface landmark located at the point of junction of the frontal bone and the two facial bones forming the bridge of the nose are the ___________________.

14. List the three pairs of scroll-shaped bones located in the nasal cavity, and identify the cranial or facial bone each is associated with.

A. ______________________ ________________

B. ______________________ ________________

C. ______________________ ________________

15. A second name for the above three pairs of bones is ________ .

16. The superior portion of the bony nasal septum is formed by the (a)_______________ of the (b) _____________, and the inferior portion by the (c) ____________________ .

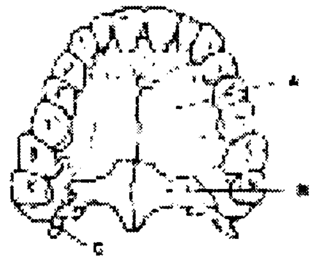
17. Identify the anatomy from the labelled drawings and list the name of the bone for which it is a part.

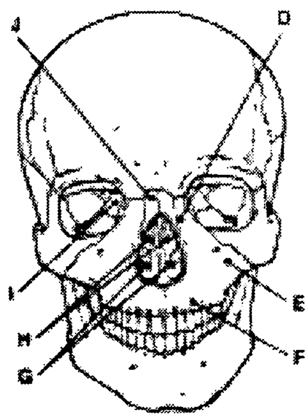
Anatomical part Name of facial or cranial bone

A. ____________ ____________

B. ____________ ____________

C. ____________ ____________





D. ____________ ____________

E. ____________ ____________

F. ____________ ____________

G. ____________

H. ____________ ____________

I. ____________

J. ____________

18. The two halves of the mandible join to form a single bone at approximately _____year(s) of age.

19. The Latin word for the chin is _____________.

20. True / False:

A. ____The symphysis of the mandible extends along the complete vertical portion of the mid anterior mandible.

B. ____"Mental protuberance" refers to the lower anterior mandible which projects forward, the centre of which is the mental point.

C. ____"Symphysis menti" is another term for the symphysis of the mandible.

21. Matching:

A. _____ part of mandible — A. coronoid process

B. _____ part of scapula — B. coracoid process

C. _____ part of proximal ulna

22. Label the following drawings of the mandible:

A. ____________________

B. ____________________

C. ____________________

D. ____________________

E. ____________________

F. ____________________

G. ____________________

H. ____________________

I. ____________________

J. ____________________

K. ____________________

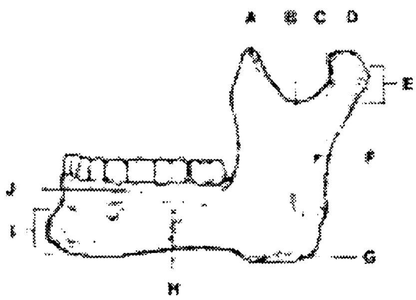
L. ____________________

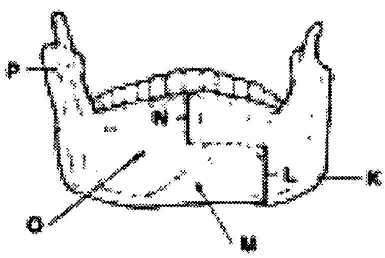
M. ____________________

N. ____________________

O. ____________________

P. ____________________





23. A. What is the name of the only synovial/diarthrodial joint of the skull?

B. What movement type(s) is this joint?

24. There are two types of fibrous/synarthrodial joints of the skull. These are the (a) ______________of the cranial bones, and the special type of joint involving the teeth and the mandible and maxillae of the subclass termed (b)________________.

25. The condyles of the mandible move (a) ______________(b) ______ (front or back) edge of the (c)______________(forward or backward) to the as the mouth is opened.

26. Fill in the secondary term for the following parts of the mandible:

A. Angle ________________

B. Condyle ______________ .

27. Each orbit is (a) shaped and is composed of parts of (b) (number) bones.

28. With the orbitomeatal line situated parallel with the floor, each orbit projects superiorly at a (a) ________degree angle, and toward the midsagittal plane at (b) ______ degrees.

29. A small opening termed the ________________ is located at the ________ of each orbit.

30. Fill in the names of the seven bones which form the orbit as indicated in this drawing:

A. ______________________

B. ______________________

C. ______________________

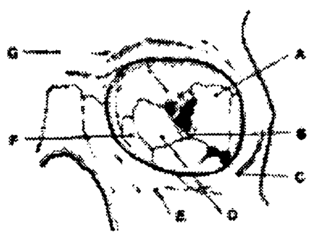
D. ______________________

E. ______________________

F. ______________________

G. ______________________

Medial Lateral



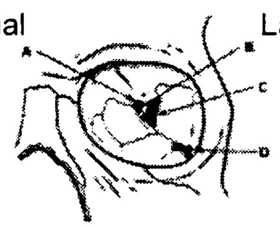
31. Fill in the name of the openings and the one structure (B) in the posterior orbits as indicated in this drawing:

A. ______________________

B. ______________________

C. ______________________

Medial Lateral



D. ______________________

32. Two fractures involving the orbit are known by their descriptive terms as (a) ________ ________and (b) __________ fractures.

PART II. RADIOGRAPHIC POSITIONING

Positioning of the Facial and Nasal Bones, Mandible and Orbits

Textbook: pp. 354-387

1. Based on the national survey (as quoted in textbook), list the most frequently performed (basic or routine) positions or projections for the following:
   - A. Routine facial bones (a) ____________________ (b) ______________________ .
   - B. Facial bones on a severely injured trauma patient who cannot be turned into a prone position
     (a)_________________________
     (b)_________________________ .
   - C. Routine nasal bones (a) ______________ (b)
   - D. Routine zygomatic arch (a) _________________ (b)
   - E. Position best demonstrating optic foramina ____________
   - F. Best demonstrates "blow-out" fractures of orbits
   - G. Routine mandible (a) _____________ (b) ____________
   - H. Routine temporomandibular joint (a) ______ or (b) ______
2. To prevent head rotation on a lateral facial bone radiograph, the (a) _______________ plane is aligned (b) _______________ to the film and the (c) _______________line is aligned to (d) _____________ to the film.

3. The ____________________ projection is another name for the Waters projection.

4. The petrous ridges should be projected directly below the (a) ____________________ in a Waters position, and projected into the lower half of the maxillary sinuses or below the (b) ________________ in a modified Waters position.

5. True or false: For a PA Waters, the distance from the tip of the nose to the table top is a good positioning method for determining the correct angle between the orbitomeatal line and the film plane _____________ .

6. In the Waters position, the (a) ______________________ line should form a (b) ____
degree angle with plane of the film, and a (c) ____ degree angle in a modified Waters.

7. In the Waters or reverse Waters position, the _________________ line should be parallel to the central ray and perpendicular to the plane of the film.

8. In the Waters position, the central ray should exit at the _______________ .

9. In addition to using a small focal spot, a (a) _____________ film holder should be used to obtain optimal detail for a lateral nasal bone radiograph. The kVp range used should be (b) ___________.

10. A good basilar or submentovertex projection requires that the central ray be at right angles to the _________________________ line, which is abbreviated as __________.

11. For the oblique axial position of the zygomatic arch, the head is turned (a) ___ degrees toward the side being examined, and the midsagittal plane is tilted (b) ____ degrees.

12. Complete the following for an AP axial projection (Towne position) for the zygomatic arches:
    A. The central ray is directed (a) ___ degrees (b) __________ (caudal or cephalic) to the (c) ___________________ line.

B. If the infraorbitomeatal line is placed perpendicular to the film, the central ray angulation should be increased to_____ degrees.

13. Indicate the correct central ray location and angulation (indicate as perpendicular if no angle) for the following:

Central Ray Location	Central Ray Angulatin
A. Lateral facial bones	____________
B. Reverse Waters	____________
C. Lateral nasal bones	____________
D. Townes for zygomatic arches	____________
E. Axial obliques for bilateral zygomatic arches	____________
F. AP axial projection of mandible	____________
G. Axiolateral oblique position of temporomandibular joints	____________

14. Complete the following for the Rhese position:

A. As a starting reference position, the three parts of the face, which should be touching the tabletop, are the_________, __________and ______________.

B. The ______________ line should be perpendicular to the tabletop and parallel to the central ray.

C. The head should be rotated ____ degrees from the PA position, which results in a ___ degree angle between the midsagittal plane and the tabletop.

D. This position will project the optic foramen into the _________________ quadrant of the orbit being examined.

15. What projection or position is most useful in visualising the condyloid processes and temporomandibular fossae? ______________________________

16. Aligning the _________________ plane perpendicular to the plane of the film for a PA mandible will prevent rotation.

17. True or false: For the routine PA projection of the mandible, a 15-20 degree caudal angulation is needed.

18. In the axiolateral projection (oblique position) of the mandible, name that portion of the mandible, which would be best demonstrated, using the following head rotations.

    A. 30-degree rotation ______________

    B. True lateral (no rotation)___________

    C. 45-degree rotation ___________

19. Why must the chin be extended when doing the axiolateral projection of the mandible?

20. For the axiolateral position a cephalic angle of approximately ____ degrees is needed to visualise the affected mandible without superimposition of the opposite mandible.

21. For a panorex of the mandible, the (a) ___________________________ line is aligned parallel with the (b) ____________.

22. A. The common name for the axiolateral position for the temporomandibular joints is the __________ method.

    B. This position requires the head to be in a true lateral position and the central ray to be angled ____degrees __________ (caudal or cephalad).

23. A. The axiolateral oblique position of the temporomandibular Joints is commonly referred to as the __________ method.

    B. This requires that the head be rotated (a) ____ degrees toward the film and the central ray angled (b) ___ degrees __________ (caudal or cephalad).

Facial bone Radiography is one of the areas in which a sound knowledge of the relevant anatomy is of the utmost importance - it will enable you to be a far more competent and skilled radiographer.

Feedback and answers to your activities and self-tests will be provided to you during contact sessions as indicated on your time tables.

 *It will take you about 60 minutes to complete this activity*

PART III. RADIOGRAPHIC PROCEDURES

LINK! Exit level outcome 1 - 3 p. 9 of Year Organiser

Specified learning outcomes 1.1-3.7 

Learning outcomes 9-18

Part A of this learning activity exercise needs to be carried out in a radiographic laboratory

A. Positioning exercise

For this section you need another person or an articulated phantom to act as your patient. Practice the following until you can do each of them accurately and without hesitation. It is important to achieve both accuracy and speed in radiographic positioning. Place a check by each position when you feel you are competent.

Include the following parameters as you simulate the basic positions or projections listed:

- correct choice of source image receptor distance
- correct size and type of film holder
- correct location of central ray
- correct centring of part to film
- correct placement of R and L markers
- accurate collimation
- proper use of immobilising devices when needed
- proper use of positioning aids as needed
- approximate correct exposure factors
- correct instructions to your patient before and during exposure.

1. Erect (with head unit if available or with erect table or other erect grid-film holder), lateral and Waters positions for the facial bones.
2. Severely injured patient who cannot be moved from a supine position on a stretcher. (Spinal injury has been ruled out by cross table lateral cervical spine.) Take a cross table lateral and a Waters position.
3. Head unit or tabletop lateral and Waters positions for nasal bones.
4. Head unit or tabletop submentovertex projection for zygomatic arches.
5. Head unit or tabletop parieto-orbital projection of the optic foramina.
6. Head unit or tabletop modified acanthioparietal projection for the orbits.
7. Head unit or tabletop axiolateral and PA projections of the mandible.
8. Head unit or tabletop axiolateral oblique position (Law Method) of the temporomandibular joints.
9. Special acanthioparietal projection to demonstrate the "floor" of orbits.

Optional: Using either a sectional or fully articulated phantom, produce a diagnostic radiograph for the following;

1. Parietoacanthial and acanthioparietal projections.
2. Parieto-orbital projection.
3. Axiolateral (oblique) projection of the mandible.
4. Axiolateral oblique position (Law Method) of the temporomandibular joints.
5. Rhese method of the orbit.
6. Nasion inferior-superior.
7. TMJ

Tip:

You should gain experience of radiographic facial bone procedures by performing the different projections on a phantom or in practice during experiential training.

Film critique and evaluation

Critique each radiograph based on evaluation criteria:

Criteria guidelines:

a. Correct film size and correct orientation of part to film?

b. Correct alignment and/or centring of part to film?

c. Correct collimation and CR location?

d. Pertinent anatomy well visualised?

e. Motion?

f. Optimal exposure (density and/or contrast)?

g. Patient ID information and markers?

h. Radiographs.

1. Lateral
2. Parietoacanthial
3. PA Caldwell
4. Submentovertex
5. Rhese oblique
6. Schuller method

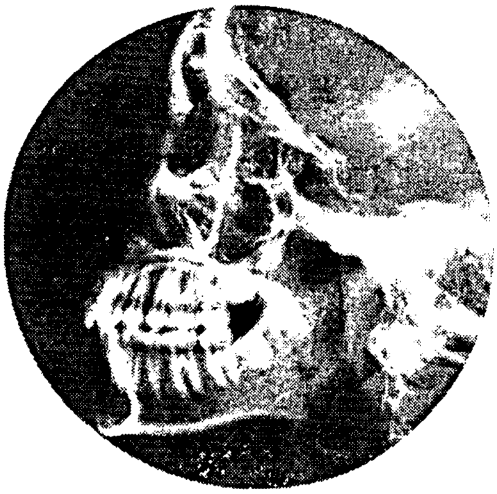
Identify the following anatomical parts:

- sella turcica
- mandible
- maxillae
- zygomatic arches
- orbital rim
- optic foramen
- temporomandibular joints
- coronoid process of mandible
- petrous ridges
- zygoma
- inferior rim of orbit
- nasal septum
- anterior nasal spine
- nasal bones
- mandibular rami
- condyloid processes of mandible
- temporomandibular fossae

C. Review of Anatomy on Radiographs

Use those radiographs provided a lateral, parietoacanthial, PA Caldwell, submentovertex, Rhese oblique, Law, and Schuller methods

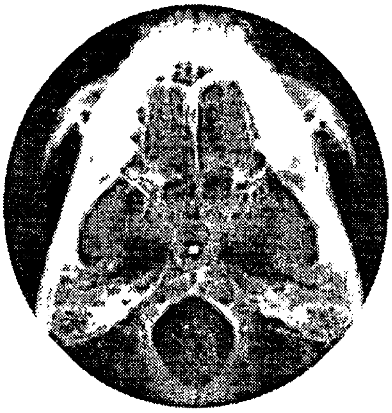
Lateral



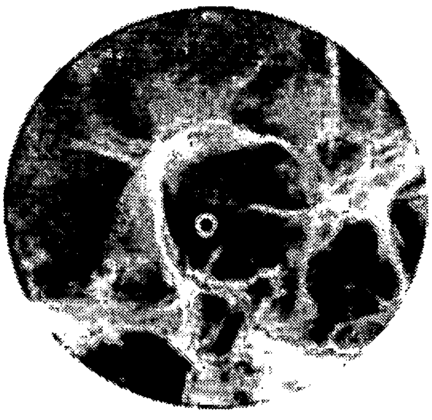
Parietoacanthial

PA Caldwell

Submentovertex



Rhese oblique

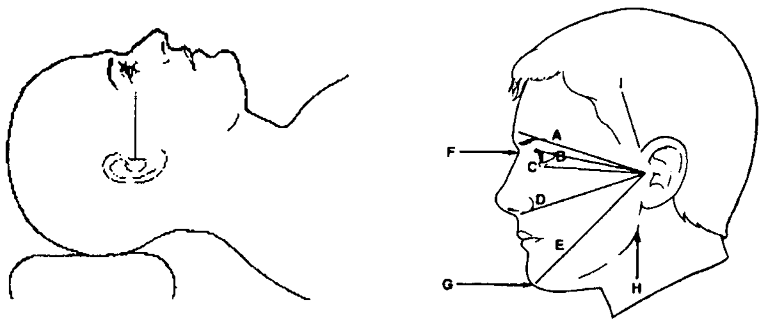


Schuller method

D. Review of Topographical Landmarks and Positioning Lines (as used for facial, mandibular, and orbital bone positioning).

Locate the following on another person:

1. Midsagittal plane
2. Interpupillary line
3. Zygoma
4. Outer canthus
5. EAM
6. Mentomeatal line
7. Acanthion
8. Orbitomeatal line
9. Infraorbitomeatal line
10. Glabello-alveolar line
11. Mandibular symphysis
12. Angles of the mandible
13. Glabella
14. Zygomatic arch
15. Zygomatic prominence
16. Three-point landing for Rhese method
17. Supercilliary arch



6. ASSIGNMENT

1. Practise and be able to demonstrate projections 1 to 9.
2. Hand in the projections 1 to 4 on the lower part of the page.
3. Complete the atached table in connection with the facial bones.

This assignment needs to be carried out in a radiographic practice/ department

For this section you need a patient or an articulated phantom to act as your patient. Practise the following until you can do each of them accurately and without hesitation. It is important to achieve both accuracy and speed.

1. Erect (with head unit if available or with erect table or other erect grid-film holder), lateral and Waters positions for the facial bones.
2. Severely injured patient who cannot be moved from a supine position on a stretcher. (Spinal injury has been ruled out by cross table lateral cervical spine.) Take a cross table lateral and a Waters position.
3. Head unit or tabletop lateral and Waters positions for nasal bones.
4. Head unit or tabletop submentovertex projection for zygomatic arches.
5. Head unit or tabletop parieto-orbital projection of the optic foramina.
6. Head unit or tabletop modified acanthioparietal projection for the orbits.
7. Head unit or tabletop axiolateral and PA projections of the mandible.
8. Head unit or tabletop axiolateral oblique position (Law Method) of the temporomandibular joints.
9. Special acanthioparietal projection to demonstrate the "floor" of orbits.

7. PRESENTATION

In groups of two prepare a clinical demonstration of the abovementioned projections.

The skills you have developed in this theme are:

NQF generic outcomes

-problem-solving

-teamwork

-organisation

-the effective use of science and technology.

8. DRAW UP A TABLE: FACIAL BONES

D. ETHICS

APPENDIX XI

Consent form

APPENDIX XI

CONSENT FORM

Technikon
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CONSENT TO USE MY ACADEMIC PROFILE

NAME: ________________________

- I certify that the lecturer has explained and informed me of the nature of the proposed study.
- I consent to the use of my academic profile and marks as necessary to compare relevant marks in a search of a teaching strategy to enhance my academic performance.
- All collected information will be handled confidentially.
- Feedback in connection with the results of the study will be provided.

Signature: ____________________

Date: ____________

APPENDIX XII

Ethics committee approval (ETOVS nr 39/03)

APPENDIX XII

ETHICS COMMITTEE APPROVAL

UNIVERSITEIT VAN DIE VRYSTAAT
UNIVERSITY OF THE FREE STATE

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Mrs G Niemand

2003-03-20

MS SM BRÜSSOW
C/O PROF MM NEL
DIVISION OF EDUCATIONAL DEVELOPMENT
INTERNAL POST BOX G14
UFS

Dear Ms Brüssow

ETOVS NR 39/03
RESEARCHER: MS SM BRÜSSOW
PROJECT TITLE: THE IMPACT OF AN INTERACTIVE EDUCATION STRATEGY IN RADIOGRAPHY EDUCATION.

You are hereby informed that the Ethics Committee approved the abovementioned study during their meeting held on the 18th March 2003.

Your attention is kindly drawn to the following:

- Failure to submit a progress report not later than one year after approval of the project may result in the termination of the study.
- That all extentions, amendments, serious adverse events, termination of a study etc have to be reported to the Ethics Committee
- These documents have been accepted as complying with the Ethics Standards for Clinical Research based on FDA, ICH GCP and Declaration of Helsinki guidelines
- Translations of the Subject Information Leaflet and Consent Form have to be submitted prior to commencement of a study.

Will you please quote the Etovs number as indicated above in subsequent correspondence, reports and enquiries.

Yours faithfully

For DIRECTOR: MEDICINE ADMINISTRATION

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