A COMPETENCY-BASED CONTINUOUS ASSESSMENT PROGRAMME AS PART OF A REVISED CURRICULUM FOR POSTGRADUATE RADIOLOGY TRAINING AT THE UNIVERSITY OF THE FREE STATE

by

JACQUES JANSE VAN RENSBURG

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CO-PROMOTER:	**PROF. DR G.J. VAN ZYL**
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Dedicated to Mianda and Naudé

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LIST OF ACRONYMS

AACTE	**American Association of Colleges for Teacher Education**
AAMC	**Association of American Medical Colleges**
ABMS	**American Board of Medical Specialties**
ABR	**American Board of Radiology**
ACGME	**Accreditation Council for Graduate Medical Education**
ACR	**The American College of Radiology**
AfriMEDS	**African Medical Education Directions for Specialists**
AIUM	**The American Institute of Ultrasound in Medicine**
AMEE	**The Association for Medical Education in Europe**
AUS	**Australia**
BC	**Before Christ**
CanMEDS	**Canadian Medical Education Directions for Specialists**
CAT	**Critically Appraised Topic**
CBD	**Case-Based Discussion**
CBE	**Competency-Based Education**
CME	**Continued Medical Education**
CMSA	**Colleges of Medicine of South Africa**
C Rad (SA)	**College of Radiologists of South Africa**
CT	**Computed Tomography**
DECT	**Dual Energy Computed Tomography**
DeSeCo	**Definition and Selection of Competencies**
DMSA	**Dimercaptosuccinic Acid**
DOM	**Dundee Outcome Model**
DOPS	**Direct Observation of Procedural Skills**
DTPA	**Diethylene Triamine Penta-Acetic Acid**
ECTJ	**Educational Communication and Technology**
EFPO	**Educating Future Physicians for Ontario**
EFPOP	**Educating Future Physicians for Ontario Project**
EOF	**Exam of the Future**
EPOC	**Effective Practice and Organisation of Care**
ERIC	**Education Resources Information Center**
EVAR	**Endovascular Aneurysm Repair**
FA	**Formative Assessment**
FID	**Free Induction Decay**
FNA	**Fine Needle Aspiration**
FRCR	**Fellow of the Royal College of Radiologists**
GIT	**Gastrointestinal Tract**
GMC	**General Medical Council (United Kingdom)**

HPCSA	**Health Professions Council of South Africa**
HRCT	**High-Resolution Computed Tomography**
HSG	**Hysterosalpingogram**
IIME	**Institute for International Medical Education**
IVP	**Intravenous Pyelogram**
JRCPTB	**Joint Royal Colleges of Physicians Training Board**
MCQ	**Multiple Choice Question**
MCUG	**Micturating Cystourethrogram**
MDT	**Multidisciplinary Teamwork**
MIBG	**Metaiodobenzylguanidine**
Mini-CEX	**Mini-Clinical Evaluation Exercise**
Mini-IPX	**Mini-Imaging Interpretation Exercise**
MRA	**Magnetic Resonance Angiography**
MRI	**Magnetic Resonance Imaging**
MSF	**Multi-Source Feedback**
MSOP	**Medical School Objectives Project**
NRF	**National Research Foundation**
NZ	**New Zealand**
OBE	**Outcomes-Based Education**
OECD	**The Organisation for Economic Co-operation and Development**
OSCA	**Objective Structured Clinical Assessment**
OSCE	**Objective Structured Clinical Examination**
PBTE	**Performance-Based Teacher Education**
PCNL	**Percutaneous Nephrolithotomy**
PET	**Positron Emission Tomography**
PET CT	**Positron Emission Tomography-Computed Tomography**
PMETB	**Postgraduate Medical Education Training Board**
PS	**Patient Survey**
PSQ	**Patient Satisfaction Questionnaire**
PTC	**Percutaneous Transhepatic Cholangiography**
QPE	**Quarterly Profile Examination**
Rad-DOPS	**Radiology Direct Observation of Procedural Skills**
RANZCR	**Royal Australian and New Zealand College of Radiologists**
RCPSC	**Royal College of Physicians and Surgeons of Canada**
RCR	**Royal College of Radiologists**
RF	**Radiofrequency**
RSNA	**Radiological Society of North America**
RSSA	**Radiological Society of South Africa**
SA	**Summative Assessment**

SAQA	**South African Qualifications Authority**
SNWG	**Societal Needs Working Group**
SOM	**School of Medicine**
TACE	**Transcatheter Arterial Chemo-Embolisation**
TO	**Teaching Observation**
UAE	**Uterine Artery Embolisation**
UFS	**University of the Free State**
UK	**United Kingdom**
UN	**United Nations**
US	**United States**
USA	**United States of America**
USOE	**United States Office of Education**
UV	**Universiteit van die Vrystaat**
VCUG	**Voiding Cystourethrogram**
VQ	**Ventilation-Perfusion**
WpBA	**Workplace-Based Assessment**

SUMMARY

Key terms: adult education; assessment; competence; competencies; competent; curriculum; formative assessment; postgraduate diagnostic radiology training; postgraduate education; workplace-based assessment.

Recent times have witnessed a shift in the educational philosophy of postgraduate radiology training programmes. Internationally, curricula have undergone revision, with many changes based on the principles of outcomes-based education. As such, these curricula prescribe learning outcomes and essential competencies – including generic competencies central to all competent physicians. Continuous assessment is commonplace and many curricula prescribe regular formal formative workplace-based assessments that contribute to learning and training.

Comparing the University of the Free Sate (UFS) postgraduate radiology training programme with the recently revised international curricula revealed several important shortcomings such as the lack of an outcomes-based educational methodology, the absence or poor definition of learning outcomes and competencies – in specific the absence of CanMEDS (Canadian Medical Education Directives for Specialists) competencies – the absence of formative assessment that culminate in feedback and remedial action, and the neglect of behaviour and attitudes during formal assessment. These shortcomings represented a problem in terms of ensuring the quality of radiology graduates and the safety of their patients.

Addressing the problem required a revision of the UFS postgraduate radiology curriculum – defining learning objectives, formulating outcomes and incorporating all required competencies – as well as the development of a formative competency-based continuous assessment programme for postgraduate radiology training.

The research was therefore aimed at the development of a competency-based, continuous assessment programme that could be integrated into a revised curriculum for postgraduate radiology training at the UFS.

The methods used to achieve this aim included a literature overview, Delphi survey and semi-structured interviews. The conceptualisation and contextualisation of postgraduate radiology education was accomplished through an extensive literature

overview that garnered information on the concepts of competence and performance-based education, as well as essential concepts related to assessment in education. The Delphi method guides decision-making through consensus; an ideal research method for determining what should and should not be included in a revised curriculum. The content of the revised curriculum was therefore researched using a Delphi questionnaire survey. The effectiveness of assessment, and decisions about its implementation, are influenced by the views and opinions of those responsible for assessment. Qualitative methods of research collect rich, detailed and descriptive data and as such, semi-structured interviews are ideal for gaining a detailed understanding of individuals' ideas and views of a particular topic. In this study, semi-structured interviews with pivotal role-players involved in South African postgraduate radiology education informed decisions about the proposed continuous assessment programme for radiology training at the UFS.

The results of the research contributed richly to achieving the aim of the research. A combination of the information from the literature overview, the results of the Delphi survey and the findings of the semi-structured interviews informed the development of the continuous assessment programme. This assessment programme was based on formative workplace-based assessments, conducted formally and resulting in feedback and remedial action. The assessments included in the programme ensured appraisal of the entire spectrum of competencies including knowledge, skills and the generic physician competencies (communication, teamwork, professionalism, management and administrative skills, research and education, and patient support and advocacy). Recommendations about curricular changes were based on information from the literature overview and the results and conclusions from the Delphi survey. Some of the more important recommendations were the compartmentalisation of the curriculum according to levels of increasing difficulty and integration, merging competencies (knowledge and skills) according to the different levels of training, the inclusion of CanMEDS-based generic physician competencies and the insertion of a summative assessment prior to independent after-hours radiology call, and a mandatory intermediate summative examination halfway through the training period.

The research culminated in the development of a performance-based formative continuous assessment programme, blueprinted on a revised postgraduate radiology curriculum – these addressed the shortcomings of the UFS postgraduate curriculum.

Assessment according to the curriculum aims to guide a registrar through the different instructional periods (training levels), document the trainee's progress and ensure the acquisition of essential competencies – all in a bid to ensure the quality of radiology graduates and the safety of the public they serve.

OPSOMMING

Sleutelterme: volwasse onderwys; assessering; bevoegdheid; vaardighede; bevoeg; kurrikulum; formatiewe assessering; nagraadse diagnostiese radiologie-opleiding; nagraadse opleiding; werkplekgebaseerde assessering.

Die opvoedkundige-filosofiese benadering tot opleidingsprogramme in nagraadse radiologie het die afgelope tyd duidelike verskuiwingstendense getoon en ondergaan. Internasionaal is kurrikula hersien en veranderinge aangebring op grond van die beginsels inherent in uitkomsgebaseerde onderwys. Hierdie hersiene kurrikula skryf bepaalde uitkomste en noodsaaklike vaardighede wat bemeester moet word, voor. Dit vervat generiese vaardighede noodsaaklik vir alle bevoegde en professionele dokters. Deurlopende assessering is 'n aanvaarde praktyk in talle kurrikula en bepaal dat gereelde, formele, formatiewe en werkplekgebaseerde assessering tydens die leer- en opleidingsproses moet plaasvind.

Die Universiteit van die Vrystaat (UV) se nagraadse radiologie-opleidingsprogram vertoon bepaalde en belangrike tekortkominge wanneer dit vergelyk word met onlangse, hersiene internasionale kurrikulavereistes. Dit sluit in die gebrek aan 'n uitkomsgebaseerde, opvoedkundige metodologie; die afwesigheid van of swak gedefinieerde leeruitkomste en vaardighede (spesifiek die afwesigheid van CanMEDS (Canadian Medical Education Directives for Specialists)-bevoegthede); die afwesigheid van formatiewe assessering wat terugvoer en regstellende optrede fassiliteer; asook 'n versuim om aandag te gee aan optrede en verhoudings tydens die formele assesseringsproses. Hierdie geïdentifiseerde tekortkominge skep 'n probleem in die nastrewing van die standaard wat gestel word vir radiologie graduandi en die veiligheid van hulle pasiënte.

Om die probleem op te los was dit nodig om die UV se nagraadse radiologie-kurrikulum te hersien, ten einde die nodige aandag aan bepaalde komponente van die opleiding te verseker. Dit sluit onder meer in die duidelike omskrywing van leerdoelwitte; die formulering van gestelde uitkomste en die insluiting van die vereiste vaardighede; asook die ontwikkeling van 'n formatiewe, vaardigheidsgebaseerde en deurlopende assesseringsprogram vir nagraadse radiologie-opleiding.

Die navorsing het dus ten doel gehad om 'n vaardigheisgebaseerde, deurlopende assesseringsprogram te ontwikkel wat in die hersiene kurrikulum van nagraadse radiologie-opleiding aan die UV opgeneem kan word.

Die metodes wat gebruik is om hierdie doelwit te bereik was 'n literatuurstudie, die Delphi-vraelysmetode en semi-gestruktureerde onderhoude. Die konseptualisering en kontekstualisering van nagraadse radiologie-opleiding is bereik deur 'n uitgebreide literatuurstudie wat inligting rakende begrippe soos bevoegdheid en uitsetgebaseerde opleiding, asook noodsaaklike begrippe met betrekking tot assessering in die onderwysgebeure, insluit. Die Delphi-metode rig die besluitnemingsproses deur konsensus, en word gesien as die ideale navorsingsmetode vir wat ingesluit of uitgelaat behoort te word in die hersiene kurrikulum. Die inhoud van die hersiene kurrikulum is dus nagevors deur die gebruikmaking van 'n Delphi-vraelysopname. Effekiewe assessering en die gebruik daarvan word beïnvloed deur die sienings en oortuigings van assessore. Kwalitatiewe navorsingsmetodes versamel 'n ryk bron van beskrywende data en daarom is semi-gestruktureerde onderhoude ideal om 'n duidelike beeld van 'n individu se idees en gevoelens met betrekking tot 'n spesifieke onderwerp te bekom. Tydens hierdie studie het die inligting en resultate van die semi-gestruktureerde onderhoude – met vooraanstaande rolspelers betrokke by Suid Afrikaanse radiologie-opleiding – besluite met betrekking tot die voorgestelde, deurlopende assesseringsprogram vir radiologie-opleiding aan die UV gerig en beïnvloed.

Die navorsingsresultate het grootliks bygedra om die navorsingsdoelstelling sinvol te bereik. Die literatuurstudie, die uitslae van die Delphi-vraelysopname en die inligting soos verkry uit die semi-gestruktureerde onderhoude het die ontwikkeling van die deurlopende assesseringsprogram bepaal en gerig. Die assesseringsprogram is gebaseer op formele en werkplekgebaseerde assesserings wat uitloop op terugvoering aan die kandidaat en gepaardgaande remediërende optrede. Die assesseringskomponent van die program verseker dat die algehele spektrum van vaardighede erkenning geniet. Dit sluit in die kennis, vaardighede en generiese bevoegdhede van 'n medikus – naamlik kommunikasie, spanwerk, professionele gedrag, bestuurs- en administratiewe vaardighede, navorsing en opleiding, asook pasiënt ondersteuning en aanbeveling. Aanbevelings rakende kurrikulêre aanpassings is gebaseer op inligting wat deur die literatuurstudie bekom is, gekombineer met die bevindinge en gevolgtrekkigs soos verkry uit die Delphi-opname metode. Van die belangrikste aanbevelings van die studie sluit in die kompartementalisering van die kurrikulum volgens vlakke van toenemende moeilikheidsgraad en integrasie, die samevoeging van bevoegdhede (kennis en vaardighede) volgens die verskillende vlakke van opleiding, die insluiting van CanMEDS-gebaseerde generiese mediese vaardighede, asook 'n summatiewe assesseringsgeleentheid voordat onafhanklike na-uurse radiologiediens gelewer word en die insluiting van 'n verpligte tussentydse summatiewe eksamineringsgeleentheid halfpad deur die opleidingstydperk.

Die navorsing het gelei tot die ontwikkeling van 'n uitsetgebaseerde, formatiewe en deurlopende assesseringsprogram, geskoei op die hersiene nagraadse radiologie kurrikulum, wat daarop gemik is om die geïdentifiseerde tekortkominge van die UV se nagraadse kurrikulum reg te stel.

Assessering volgens die kurrikulum is daarop gemik om die student deur die verskillende opleidingsvlakke te lei, om vordering te dokumenteer en om die gehalte van die radiologie graduandi, asook die veiligheid van die publiek wat hulle bedien, te verseker.

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

In this research project, the researcher undertook an in-depth study with a view to developing a formative, competency-based, continuous assessment programme for postgraduate radiology training at the University of the Free State (UFS).

The seamless and successful integration of the newly developed continuous assessment programme into the existing postgraduate radiology training programme at the UFS required a revision of the existing curriculum – not only bringing it in line with outcomes-based educational (OBE) principles that have been introduced into medical education worldwide, but also updating it in terms of radiology-specific content and non-radiological key competencies essential to the training of a competent medical practitioner.

Change has been the mantra for diagnostic radiology and postgraduate radiology training during the past decade. An Internet search for published articles on the changes in postgraduate radiology training in First-World countries, most notably the United States of America (USA), will reward the reader with several articles published in some of the leading international radiology journals. In these articles, the authors address various topics related to the postgraduate training and examination of registrars (or residents) in diagnostic radiology, such as competency- and outcomes-based education and training, core training and subsequent focused training in a chosen area(s) of interest, mechanisms to increase subspecialisation during residency training, continuous assessment, the timing of the written examination and the final examination, as well as changes in the format of both examinations.

In accordance with these changes, many countries have revised their postgraduate radiology training curricula. These revised curricula incorporate OBE principles, predefined competencies and learning outcomes, and include the appropriate assessment tools and methods needed to assess attainment of these outcomes and mastery of the competencies.

Without evidence of a learner's ability to fulfil a required competency, it is not possible to judge the success of that individual's learning (Gruppen, Mangrulkar & Kolars 2010:18). More traditional assessment, with a number of exams interspersed at variable times during the course of training to act as a stimulus to the acquisition of knowledge as well as hurdles to be crossed, is insufficient on its own in this era of competency- and outcomes-based education. Performance-based education (either competency- or outcomes-based education) requires continual assessment, both formative and summative, with the objective of ensuring clinical competence (Lindsell 2008:2), because without assessment, competency-based education "becomes little more than traditional education with a more clearly defined set of goals and objectives" (Gruppen *et al.* 2010:18). Lindsell (2008:3) also points out that assessment should be in line with the curriculum and that it should be fair, reliable and valid, whilst Epstein and Hundert (2002:229) are of the opinion that good assessment contributes to learning and should provide guidance and support to address the learner's educational needs. Formative assessment aims at addressing these educational needs by using the knowledge and information gained through assessment to modify the teaching and learning activities of individual students during their entire training programme.

In terms of content, it is common to find, interwoven into these revised curricula, a set of topics which addresses key competencies beyond the scope of the clinical educational experiences usually offered by radiology but essential to the training of a competent medical practitioner. These topics include ethics, socioeconomics, research design, biostatistics, skills required for critical review of the literature and, importantly, generic elements related to 'medical professionalism' based on the CanMEDS (Canadian Medical Education Directions for Specialists) principles. The CanMEDS Physician Competency Framework of 2005 (Frank 2005:9-23) identifies, apart from the role of medical expert, six non-medical roles which it believes encompass the competencies of the specialty. These are:

- communicator, which refers to communication skills;
- collaborator, which refers to teamwork;

- manager, which refers to management and administrative skills;
- health advocate, which refers to patient support and advocacy;
- scholar, which refers to research and education; and
- professional, which encompasses professionalism (Frank 2005:9-23).

This study can serve as a directive for postgraduate diagnostic radiology education in South Africa.

The aim of the first chapter is to orientate the reader to the study. It provides a background to the research problem, followed by the problem statement – including the research questions, the overall goal, aim and objectives of the study. These are followed by a demarcation of the study and highlight the significance and value of the study. Thereafter, a brief overview of the research design and methods of investigation are presented. This chapter is concluded by a layout of the subsequent chapters and a short, summative conclusion.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

Since the discovery of X-rays by Wilhelm Roëntgen in 1895, the world has witnessed the progressively sophisticated utilisation of X-rays and other energy sources, such as ultrasound, magnetic resonance imaging and radio-isotopes (nuclear medicine), in obtaining increasingly more accurate and detailed imaging of human anatomy, physiology and pathology. Because of these advances, radiological (medical) imaging has become the best practical way to diagnose and monitor the treatment of many important and common diseases in a minimally invasive and anatomically precise manner. Radiology therefore finds itself central to the clinical practice of medicine across a range of disciplines. For the past thirty years, technological advances in the field of diagnostic radiology have also enabled the interventional radiologist (a medical sub-specialty of diagnostic radiology) to utilise minimally invasive image-guided procedures to diagnose and treat diseases in nearly every organ system in the human body.

As a consequence of the increasing sophistication and accuracy of clinical imaging, the utilisation and importance of radiology have increased dramatically over the past decade. As the specialty of diagnostic and interventional radiology develops and expands, demands on the radiologist’s skills and knowledge continue to increase. It is, however, not only the advances in medical imaging, their applications and the subsequent changes these have brought about in the management of patients that has necessitated the revision of postgraduate radiology education worldwide. Social demands and the changing role of medicine are also driving changes to the content and quality of postgraduate curricula. As a result, postgraduate radiology training programmes and the assessment of registrars in particular, along with medical education in general, have come under the spotlight in many countries around the world.

The Flexnerian model of more passive learning through apprentice-style, on-the-job training is being challenged and replaced by a more formal medical educational process based on a broader and sounder adult education theory that requires a student to take on a more active role in his/her own training (Carraccio, Wolfsthal, Englander, Ferentz & Martin 2002:361-367).

The value and credibility of a postgraduate training programme used to lie in its potential to train residents, based on the assumption that if the programme material was good, and the teaching was good, then training should be adequate and result in a competent physician. This is changing, and training programmes are now being assessed, not on the programme's potential, but rather in terms of whether residents actually achieve the desired learning objectives. The emphasis in medical training is shifting from passive acquisition of knowledge towards active learning, according to the authors of the article *The changing face of medical curricula* (Jones, Higgs, De Angelis & Prideaux 2001:699), with assessment focusing on clinical competence rather than on the ability to retain and recall unrelated facts. This increased focus on educational outcomes in medical education has led to the adoption of a competency-based framework as the underpinnings for newly revised postgraduate training programmes. These training programmes rely on the mastery of various predetermined educational outcomes and/or competencies (involving knowledge, skills, behaviour and attitudes), which cumulatively lead to competence.

Although not prescriptive in terms of teaching and learning, this approach to education focuses on learner-centred education and discourages traditional education approaches based on direct transmission of facts and information. This constructivist approach encourages the student to actively participate in the learning process instead of being a passive recipient of information. This method of education places the responsibility of learning primarily with the learner, unlike previous educational viewpoints where the responsibility for teaching rested with the teacher and where the learner played a passive, receptive role. In this instance, the role of the teacher becomes that of a facilitator, someone who helps the learner to get to his or her own understanding of the content, rather than being just a provider of information and unrelated facts that have to be assimilated by the student.

The postgraduate diagnostic radiology training programme at the University of the Free State (UFS) spans over a five-year period (contrary to the four-year programme offered at some other South African universities) (UFS 2014:44). The curriculum focuses predominantly on the theoretical knowledge (physics, pathology, anatomy and diagnostic radiology) essential to the training of a radiology registrar and forms the basis for the rotational five-year modular academic programme. In addition to the speciality-specific content, the student also has to complete a compulsory research component consisting of two modules, namely Research Methodology (NAM701) and a Comprehensive Mini-dissertation (NAM702), as well as a module on Health Care Practice (GPV703) (UFS 2014:37-38). Except for NAM701 and NAM702, the curriculum unfortunately fails to define any learning outcomes, and competencies are neither described nor prescribed. General competencies (such as the CanMEDS or AfriMEDS principles) and competencies related to skills and attitudes are also not yet included in the curriculum and therefore do not form part of registrar assessments.

The department's formal assessment programme requires the registrar to undergo an assessment after their first ultrasound, computed tomography, fluoroscopy and MRI (Magnetic Resonance Imaging) rotations, with the evaluations supervised by the consultant radiologist responsible for that rotation. Present assessment outcomes are, for the most part, too generic and fail to focus on the knowledge, skills and attitudes essential to a specific modality, with the registrar having no prior knowledge of the outcomes and competencies expected for that specific assessment. The assessments also make no allowance for any formal feedback, or modulation of future learning, resulting in predominantly summative assessment. Recently introduced quarterly assessments include a rapid reporting film session, image-based long cases and written long questions with the subject matter involving the diagnostic radiology domains covered at the academic afternoons over the past quarter. These, together with the above-mentioned evaluations, accumulatively count toward the final decision to allow a candidate to attempt the final examination. Unfortunately, they also neglect to influence the registrar's training. Formal assessment, in its present form, is therefore neither formative, nor is it competency- or outcomes-based education and would seem to contribute very little, if any, to the student's training.

At the time of the research, the College of Radiologists (member of the College of Medicine of South Africa) played no role in the continuous in-training assessment of registrars at the UFS. The role of the College of Radiologists – in terms of postgraduate radiology assessment – was limited to the final (summative) exit examination at the end of the registrars' training period.

It is important to note that the focus of this study was limited to the postgraduate radiology education and training programme at the University of the Free State and as such, a discussion of the postgraduate radiology training programmes of the other academic institutions throughout South Africa, fall outside the scope of this thesis; however, where applicable, reference to certain aspects of these training programmes were made.

1.3 PROBLEM STATEMENT

The problem that was addressed encompasses the shortcomings of the postgraduate radiology training programme at the UFS, which include:

- the lack of an outcomes-based educational methodology,
- the absence or poor definition of learning outcomes and competencies,
- the absence of CanMEDS based generic physician competencies,
- the absence of formative assessment of a registrar's progress and competence in terms of knowledge, skills and attitudes, and
- the absence of positive feedback and guidance of future learning in order to address identified weaknesses or inadequacies.

No recent (or any) study concerning the development of a continuous formative assessment programme could be traced as far as postgraduate radiology education in South Africa is concerned. Searches on the NRF website and NEXUS database system did not identify any relevant dissertations. The researcher also searched the Cochran library, Cochrane effective practice and organization of care (EPOC) group database, Medline database, EMBASE, and best-evidence medical education database to identify relevant articles.

A number of studies/scholarly works relating to postgraduate radiology education were found. Some sections within these dissertations/theses and articles were informative and helpful and are acknowledged and referenced as such.

In conclusion, there seemed to be no recent published scientific research into the development of a competency-based continuous assessment programme for postgraduate radiology education in South Africa.

Addressing the shortcomings of the postgraduate radiology training programme at the UFS required:

1. conceptualisation and contextualisation of postgraduate radiology education;
2. a review of the curriculum for postgraduate radiology training at the UFS;
3. proposing additions and changes to the postgraduate radiology curriculum where deemed necessary; and
4. submitting a competency-based assessment programme for postgraduate radiology training at the UFS.

These actions were subsequently undertaken guided by these three research questions:

1. *How to contextualise and conceptualise postgraduate radiology education?*
2. *How to revise the curriculum for postgraduate radiology training at the UFS?*
3. *How to develop a competency-based continuous assessment programme for postgraduate radiology training at the UFS?*

An overview of relevant literature underpinned the contextualisation and conceptualisation of postgraduate radiology education, whilst the empirical research component of this study addressed relevant aspects of the curriculum and proposed formative continuous assessment programme (*cf.* Chapters 4 and 5).

1.4 OVERALL GOAL, AIM AND OBJECTIVES OF THE STUDY

The goal, aim and objectives of the study were as follows:

1.4.1 Overall Goal of the Study

The overall goal of the study was to improve postgraduate diagnostic radiology training at the UFS through a more structured approach to the training and assessment of registrars. This will provide the platform to ensuring that registrars are adequately prepared for their final examination (with the best possible chance of success), but, perhaps more importantly, that graduates are ethical, competent specialist physicians who are able to truly meet the needs of their patients and who can improve the healthcare of the population that they serve.

1.4.2 Aim of the Study

This study was aimed at developing a competency-based, continuous assessment programme to be integrated into the curriculum for postgraduate radiology training at the UFS. Secondly, the study aimed to review the current UFS postgraduate radiology curriculum and propose changes aimed at improving and updating the existing curriculum, whilst at the same time bringing it in-line with modern educational concepts.

The comprehensive revision of a curriculum is an arduous task that requires the dedication of a qualified and committed panel of experts. A complete revision of the UFS postgraduate radiology curriculum was therefore never on the cards and a revision of the South African postgraduate radiology curriculum fell outside the scope of this study.

1.4.3 Objectives of the Study

To achieve the aim of the study, the following objectives where pursued:

1. ***The contextualisation and conceptualisation of radiology education and training, both internationally and in South Africa***

   This was achieved by conducting a thorough literature overview on the topic of postgraduate radiology training (in the South African context and internationally) in order to compile a theoretical framework for the study.

   This objective addresses research question One.

2. ***A revision of the UFS postgraduate radiology curriculum, defining learning objectives and formulating outcomes, incorporating all required competencies***

   Information gathered from the literature overview gave insight into the latest design of postgraduate radiology curricula in First-World countries such as the USA, United Kingdom, New Zealand and Australia. This information formed the underpinnings of fundamental changes to the existing curriculum for postgraduate radiology training at the UFS – all within the South African context. A Delphi questionnaire survey shed light on the content of the curriculum and helped define outcomes for the curriculum.

   This objective addresses research question Two.

3. ***The development of a transparent, accountable, appropriate and formative competency-based continuous assessment programme for postgraduate radiology training (at the UFS).***

   A literature overview of assessment methods used in general education, medical education, and radiology postgraduate education in particular, was undertaken. The Delphi survey, used to gain expert opinion with regard to the postgraduate radiology curriculum, also provided information on the assessment of registrars; information that was used in the development of the continuous assessment programme. The chosen assessment methods, their inclusion in the continuous assessment programme, as well as the assessment programme itself, were then discussed during semi-structured interviews, before finalisation of the assessment programme.

   This objective addresses research question Three.

1.5 DEMARCATION OF THE FIELD AND SCOPE OF THE STUDY

The study fits in the field of Health Professions Education and lies in the domain of academic programme development and continuous assessment. Due to the application of the study in the field of Medicine, namely Radiology Education, the study can be classified as interdisciplinary.

The scope of this study was restricted to postgraduate radiology training at the University of the Free State with a specific focus on continuous and formative in-training assessment. By its very nature, this study never intended (nor was it included in the aim of this study) to present a completely new curriculum for postgraduate radiology training at the University of the Free State or South Africa, compare the 'old' and 'new' curriculum or address the final summative radiology exit examination.

This study, despite being limited to post-graduate radiology education at the UFS, however hopes to spark debate about, and contribute to, a uniform curriculum for post-graduate radiology education in South Africa which is based on sound educational principles, integrates effective assessment and is on par with international standards whilst appropriate for the South African context.

In a personal context, the researcher of this study is a qualified diagnostic and interventional radiologist (having completed a fellowship in interventional radiology at the UFS) with eight years' postgraduate experience. During this time he has been working as a full-time consultant in academic radiology at academic training units in South Africa. This continued exposure to registrars and academic radiology fostered an interest in the training of registrars. Changes to postgraduate radiology training in America, New Zealand, Australia and the United Kingdom prompted a critical evaluation of postgraduate radiology training at the UFS, which exposed shortcomings in the approach to postgraduate radiology education throughout South Africa; this awareness and a desire to contribute to the improvement of postgraduate radiology education led to this study.

As far as the timeframe is concerned, the study was conducted between June 2012 and June 2015, with the empirical research phase from August 2013 – October 2014.

The findings of the study may be applied to postgraduate radiology training at academic training units across South Africa.

1.6 SIGNIFICANCE AND VALUE OF THE STUDY

Worldwide, the old model of learning through an apprenticeship relationship with senior clinical colleagues over long working hours and seeing large numbers of normal and pathological cases, is being challenged. This has resulted in curricula being revised and developed into competency- or outcomes-based models, which include generic elements related to professionalism (such as the CanMEDS principles) and specialty-specific educational components. Whilst the curricula clearly define learning outcomes, outlining what knowledge, skills, attitudes and behaviours are expected of the candidates, a closely matched assessment programme guides both candidate and the educators through the process of achieving these outcomes (Lindsell 2008:2-4).

At the UFS (as at most, if not all, of the other medical academic departments throughout South Africa) much of the learning still depends on the apprenticeship relationship and self-learning; in other words, independent, self-directed and motivated predominantly by a candidate's internal drive. Radiology will always benefit from this mentoring and apprenticeship of trainees (which also serves as a method of continuous assessment), but the increasing demands of service delivery and more and more clinicians acquiring radiology diagnostic interpretive skills necessitate a more structured approach to postgraduate radiology education.

At present, registrars have little guidance in terms of the knowledge, skills and attitudes that they are expected to acquire during their residency. For the most, they have to rely on themselves, their peers and the (sometimes biased) opinion of consultants to determine their level of competence, which in itself lacks definition. This often results in a frenzied period of studying immediately prior to the finals, solely with the aim of passing the exam, instead of demonstrating that they have acquired a competent working knowledge through their years of residency. Continuous formative assessment prevents 'unexpected failures' in the final examination and aims to identify the *weaker* candidate and not leave it to the final year before discovering that the individual should never have been allowed to continue this far.

The value of this thesis therefore lies in addressing these issues, firstly through the revision of the curriculum – defining learning objectives and formulating outcomes, incorporating the CanMEDS and AfriMEDS principles and updating the content to ensure that qualifying radiologists are equipped to meet the increasing demands being placed on them by clinicians, patients and the legal system; and, secondly, through the implementation of a formative developmental continuous assessment programme that will guide a candidate through his/her five years of study, allowing for self-evaluation in terms of progress and assessment by the teaching body in terms of attaining competencies as outlined in the curriculum.

Standardised assessment tools applied individually by various assessors will ensure reliability and reproducibility, whilst multiple sources of evidence will strive to ensure validity of the assessment. The developmental and formative nature of the assessments will allow for positive feedback following each individual assessment. These feedback sessions will inform a candidate of his/her progress and through (constructive) identification of weaknesses, guide further learning.

The changes to the curriculum and the implementation of the continuous assessment programme should ensure that clinical competence will have been achieved – and proven – by the end of the training period. Herein lies the significance of this study, that it will ensure that registrars are optimally prepared for their final examination, that they are fully trained in all required competencies and that graduates are competent specialist physicians who are skilled and knowledgeable, and demonstrate a caring attitude and behave professionally.

1.7 RESEARCH DESIGN OF THE STUDY AND METHODS OF INVESTIGATION

1.7.1 Design of the Study

This research project is multifaceted, with certain areas of the study lending themselves to qualitative research whilst other aspects were better researched employing a quantitative design. Subsequently, both quantitative research methods (Delphi) and qualitative research methodology (semi-structured interviews) were employed during the course of this research. As the two designs were not used to interrogate the same phenomenon within the research study, the researcher feels that the term mixed-method research is not applicable in this instance.

The more structured quantitative research, utilising statistical analysis of a controlled dataset (obtained using the Delphi method), was used in defining outcomes related to the curriculum – outcomes that were used in the structuring of the assessment programme.

The qualitative research, on the other hand, allowed the researcher a broader and less restrictive means of gathering information, allowing for interpretation and the forming of theories, opinions and views. This research methodology was used in the design of the competency-based continuous assessment programme, where the basis for the programme came from available data and established methods (literature overview) and information gathered during the Delphi survey, but the final design was influenced by opinions and ideas emanating from semi-structured interviews.

1.7.2 Methods of Investigation

The methods that were used and which formed the basis of the study comprised an overview of the literature and empirical research consisting of a Delphi process and semi-structured interviews.

The research included a literature overview that focused on radiology education in South Africa, worldwide changes in radiology education at a postgraduate level over the past 10-15 years, changes that have been made to curricula for postgraduate radiology training in countries such as the Unites States of America (The American Board of Radiology [ABR]), New Zealand and Australia (The Royal Australian and New Zealand College of Radiologists [RANZCR]) and the United Kingdom (The Royal College of Radiologists [RCR]), and the CanMEDS principles and how these have influenced curricula for postgraduate radiology training worldwide. The literature overview also brought to light the latest research on various assessment methods being used in postgraduate medical education and in the other spheres of education, that were considered in the development of the outcomes-based education continuous assessment programme; these included workplace-based assessment methods such as Direct Observation of Procedural Skills and Rad-DOPS (Radiology Directly Observed Procedural Skills), Multi-Source Feedback, Mini-Imaging Interpretation Exercise (Mini-IPX), Mini Clinical Evaluation Exercise (Mini-CEX), Critically Appraised Topics and Teaching Observation, as well as the Progress test and the use of portfolios in postgraduate medical education. The information accumulated during the literature overview formed the underpinnings of the revision of the existing curriculum and the development of the assessment programme.

In this study, a Delphi survey was used to determine which components of the existing curriculum, presently in use at the UFS and at educational institutions across South Africa, to retain or discard and which new concepts (as identified through the literature overview) to include. A further aim of the survey was an attempt to define or predict the future role of the radiologist. It is important to gain insight into what the role players in South African postgraduate radiology education envisage as the future role of the radiologist, as this dictates – or at least should dictate – how we educate registrars, which in turn influences the curriculum. Information gathered during the Delphi survey also contributed to the development of the assessment framework in terms of content (what we need to assess) and timing (when should we assess it) in relation to the curriculum.

Individual, one-on-one, semi-structured interviews were held with a selection of academic role-players (involved in postgraduate radiology training in South Africa) in order to discuss the preliminary continuous assessment framework. Information gained from the interviews was then used to refine and finalise the continuous assessment programme.

The results from the literature overview, the Delphi survey and the semi-structured interviews were therefore used to develop, construct and finalise a formative continuous assessment programme for postgraduate radiology education – the results were also used in the review and update of the existing curriculum for postgraduate radiology training in use at the University of the Free State.

The detailed description of the population, sampling methods, data collection and techniques, data analysis and reporting and ethical considerations are discussed in Chapter 3.

A systematic overview of the study is given in Figure 1.1 (*cf.* page 14):

Figure 1.1 A Schematic overview of the study (compiled by the researcher, Janse van Rensburg, 2013).

1.8 IMPLEMENTATION OF THE STUDY

This report containing the findings of the research will be brought to the attention of the Management of the College of Radiologists of South Africa and the Radiological Society of South Africa (RSSA). It will furthermore be recommended that the model that was developed should be implemented at the UFS and that it may be adapted to make it suitable for other radiology training units throughout South Africa.

The research findings will be submitted to academic journals with a view to publication, as the researcher hopes to make a positive contribution to postgraduate radiology education in South Africa. The research findings will also be presented at conferences.

1.9 ARRANGEMENT OF THE THESIS

To provide more insight into the topic, the methods used to find solutions and the final outcome of the study will be reported on as follows:

In this chapter, Chapter 1, ***Orientation to the Study***, the background to the study was provided and the problem, including the research questions, was stated. The overall goal, aim and objectives were stated and the research design and methods that had been employed were briefly discussed to give the reader an overview of what the report contains. It further demarcated the field of the study and the significance of the study for higher education and postgraduate radiology education.

In Chapter 2, ***Competency-Based Continuous Assessment in Postgraduate Radiology Training***, the conceptualisation and contextualisation of outcomes-based education, postgraduate radiology training, assessment in postgraduate radiology training and postgraduate radiology training curricula will be discussed. This chapter will serve as the theoretical framework for the study.

In Chapter 3, ***Research Design and Methodology***, the research design and the methods applied will be described in detail. The data collecting methods and data analysis will be discussed. The Delphi technique, which was employed to gain ideas and opinions on the topic of postgraduate radiology training from a panel of experts, will be described. This will include the way in which the Delphi questionnaire was constructed and how the data were processed. The semi-structured interviews, used to gain rich information (from educators and examiners involved in postgraduate radiology) on the proposed/preliminary continuous assessment programme will also be described.

In Chapter 4, ***Discussion of the Results: Delphi Questionnaire***, an exposition and discussion of the findings of the Delphi process will be provided.

In Chapter 5, ***Discussion of the Findings: Semi-Structured Interviews***, an exposition and discussion of the findings of the semi-structured interviews will be provided.

In Chapter 6, ***A Competency-Based Continuous Assessment Programme as part of a Revised Radiology Curriculum for Postgraduate Training at the University of the Free State***, the final competency-based continuous assessment programme and its integration into the curriculum for postgraduate radiology training (at the University of the Free State) will be discussed in detail.

In Chapter 7, ***Conclusion, Recommendations and Limitations of the Study***, an overview of the study, and the conclusion and recommendations will be given, and the limitations of the study will be discussed.

1.10 CONCLUSION

Chapter 1 provided the background and introduction to the research undertaken regarding the development of a competency-based continuous assessment programme as part of a revised curriculum for postgraduate radiology education and training at the University of the Free State.

The next chapter, Chapter 2, entitled **Competency-Based Continuous Assessment in Postgraduate Radiology Training**, summarises the literature overview (*cf.*1.7.2)

CHAPTER 2

COMPETENCY-BASED CONTINUOUS ASSESSMENT IN POSTGRADUATE RADIOLOGY TRAINING

2.1 INTRODUCTION

Advances in medical imaging, along with an increasing social demand for accountability, have necessitated the review of numerous international postgraduate radiology training programmes. Recognising the value of modern adult education principles, these revised training programmes have adopted an outcomes-based approach to postgraduate training and the methods used to assess the acquisition of competencies. It is here that radiology finds itself in a unique position, able to combine what was best in the past (the close mentoring and apprenticeship of trainees) with the more recent outcomes-based approach to postgraduate training.

In this chapter, postgraduate radiology education is conceptualised and contextualised from an adult education perspective. Issues dealt with include modern educational concepts such as competence, outcomes-based education (OBE) and competence-based education (CBE); curricular changes in international postgraduate radiology education (in specific, changes made to the curricula of the ABR, RCR and RANZCR); and an overview of relevant concepts in educational assessment such as formative and summative assessment, workplace-based assessment methods, portfolios and the progress test.

For a schematic overview of the different aspects that will be discussed and that will constitute the theoretical framework for the study, see Figure 2.1.

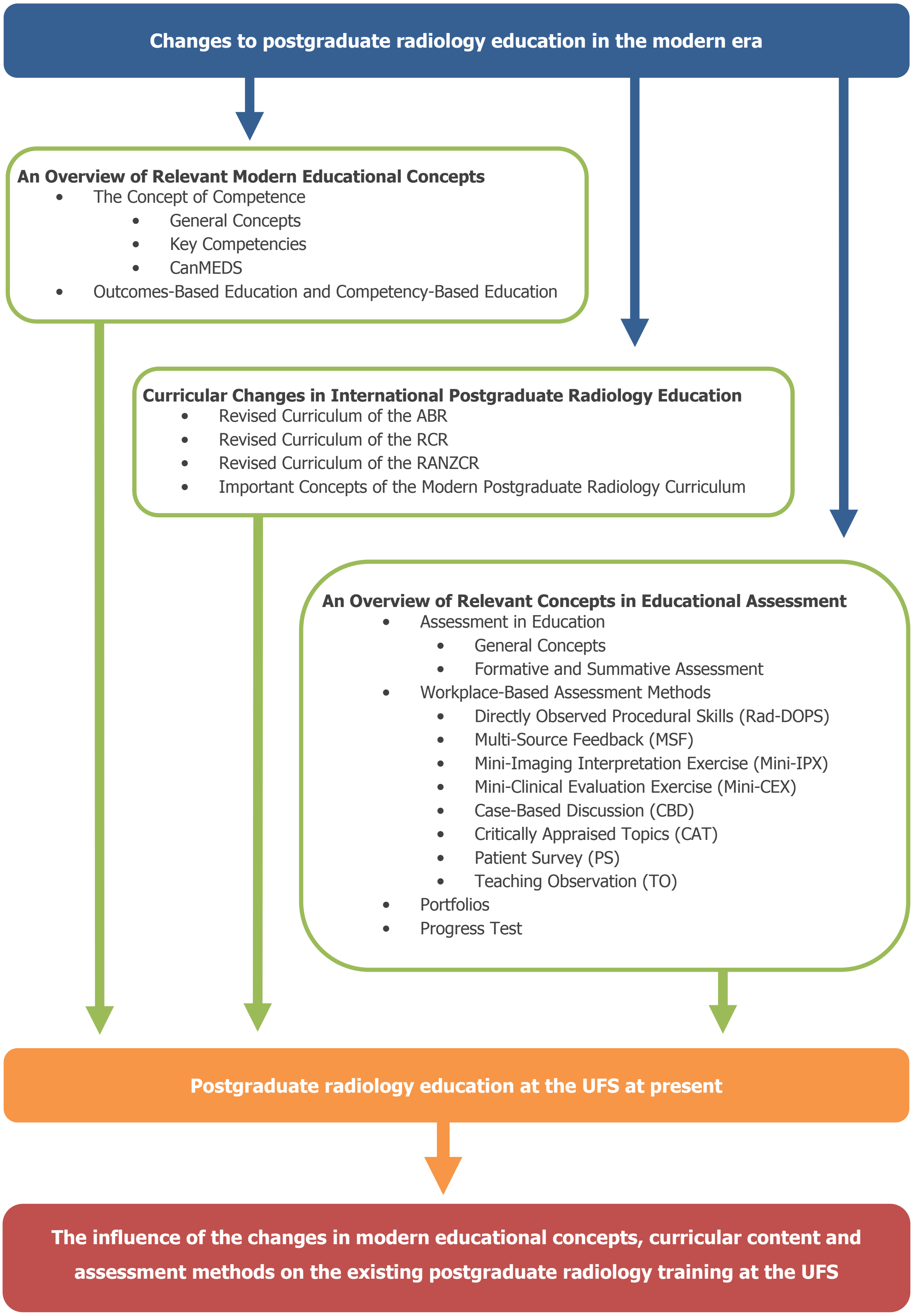

Figure 2.1 A diagrammatic overview of the different aspects that will be discussed in this chapter (compiled by the researcher, Janse van Rensburg (2013), as part of the Ph.D. study).

2.2 CHANGES TO POSTGRADUATE RADIOLOGY EDUCATION IN THE MODERN ERA

Higher education has been subject to numerous changes over the past decade or two. New concepts in and new approaches to teaching, learning and assessment, and changes to curricula have seen the light on a regular basis due to an unremitting stream of research results, as it became clear that in a global knowledge-oriented economy, education plays a central role in development. These changes have gone on to influence both under- and postgraduate medical education, and postgraduate radiology training is no exception.

2.2.1 An Overview of Relevant Current Educational Concepts

Two concepts that feature prominently in current discussions about educational change are those of competence and outcomes-based education.

2.2.1.1 *The Concept of Competence*

The American psychologist, Robert White (1904-2001) in 1959 introduced the term competence "to describe those personality characteristics associated with superior performance and high motivation", conceptualising competence as an "effective interaction of the individual with the environment" (Le Deist & Winterton 2005:31).

In 1973, David McClelland published the article *Testing for Competence Rather Than for "Intelligence"* in which he argues for tests that assess competencies, as opposed to aptitude or intelligence. He contends that the commonly used, traditional intelligence tests are poor predictors of successful performance. With regard to the assessment of competencies, he holds that these should include traditional cognitive competencies (involving reading, writing and calculating skills) and personality variables (which he thought might better be considered competencies) such as communication skills, patience, moderate goal setting and ego development (McClelland 1973:10). In later years McClelland (1998) held that unlike personality and intelligence, competencies are fundamentally behavioural and can be learned through training and development (Le Deist & Winterton 2005:31).

Definition and characteristics of competence

There have been numerous and varied definitions of the term competence (or competency) over the past years – evidence of the confusion around the concept of competence and a general lack of rigor and consistency in the use of terms related to competence (*cf.* Table 2:1).

Table 2.1 Examples of definitions of competence/competency [Table continues on next page].

"*Competence* [is the] ability to handle a situation (even unforeseen)" (Keen 1992:115).
"*Competence* is a compound, made up of different parts just like the fingers of a hand (i.e. skills, knowledge, experience, contacts, values, and additionally coordination which is located in the palm, and supervision, symbolized by the nervous system)" (Keen 1992:112).
"A *competency* is an underlying characteristic of an individual that is causally related to criterion-referenced effective and/or superior performance in a job or situation. Underlying characteristic means the competency is a fairly deep and enduring part of a person's personality and can predict behaviour in a wide variety of situations and job tasks. Causally related means that a competency actually causes or predicts behaviour and performance. Criterion-referenced means that the competency actually predicts who does something well or poorly, as measured on a specific criterion or standard" (Spencer & Spencer 1993:9).
"A *competency* is a cluster of related knowledge, skills and attitudes that affects a major part of one's job (a role or responsibility), that correlates with performance on the job, that can be measured against well-accepted standards, and that can be improved via training and development" (Parry 1996:50).
"*Competency* is a knowledge, skill, ability, or characteristic associated with high performance on a job, such as problem solving, analytical thinking, or leadership. Some definitions of a competency include motives, beliefs and values" (Mirabile 1997:75).
"Clinical *competence* exists when a practitioner has sufficient knowledge and skills such that a procedure can be performed to obtain the intended outcomes without harm to the patient" (Miller 1997:231-240).
"Human *competence* ... is displayed [behaviour] within a specialized domain in the form of consistently demonstrated actions of an individual that are both minimally efficient in their execution and effective in their results" (Herling 2000:20).
"...*competence* in medicine [is] the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and community being served" (Epstein & Hundert 2002:226).

"A *competence* is the ability to meet a complex demand successfully or carry out a complex activity or task. The concept of competence is used to refer to the necessary or desirable prerequisites required to fulfil the demands of a particular professional position, of a social role, or a personal project" (Rychen & Salganik 2002:5).

From these somewhat varied definitions (*cf.* Table 2:1) one can already identify several characteristics of competence, namely

- *competence* describes a complex behaviour;
- *competence* consists of various interrelated components such as skills, knowledge, experience, ability, values, attitudes, motives, beliefs, emotions, communication, problem solving ability, analytical thinking, clinical reasoning ability, reflection ability, etc.;
- *competence* predicts behaviour and performance;
- *competence* correlates with adequate or superior performance;
- *competence* can be taught, or at least improved, via training and development;
- *competence* can be evaluated against specific criteria or standards;
- *competence* can be proven (easier said than done); and
- *competence* is to the advantage of the individual and community being served.

Confusion surrounding the concept of competence

The literature is abound with authors bemoaning the lack of uniformity as concerns the precise definition/understanding of competence (as well as competency and competencies for that matter).

In their 2002 essay, *The Boundary Approach of Competence: A Constructivist Aid for Understanding and Using the Concept of Competence*, Stoof, Martens, Van Merriënboer and Bastiaens (2002) argue that no theoretical framework for competence exists, ergo no true definition of competence (Stoof *et al.* 2002:345).

Le Deist and Winterton (2005:29), alluding to the ongoing confusion and debate regarding the concept of competence, contend that it is impossible to arrive at a definition that can accommodate the varied ways in which the term is used.

Van der Klink and Boon (2002), who describe competence as a *fuzzy* concept that "bridges the gap between education and job requirements" (Winterton, Le Deist &

Stringfellow 2006:29), also found considerable lack of uniformity concerning the definition of competence. In their 2007 essay, they point out the different views of the concept of competence with regard to teaching theory (constructivism versus cognitive teaching theory) and the area of application (acquisition and selection vs. teaching and training vs. job evaluation vs. performance pay); they also highlight the different meanings of competence in different countries (Van der Klink, Boon & Schlusmans 2007:69-71).

Examples of the different ways in which competence has been defined, described or interpreted, such as the nine examples listed by Weinert (1999:6) – competence as general cognitive abilities, specialized cognitive skills, a competence-performance model, a modified competence-performance model, motivated action tendencies, objective and subjective self-concepts, action competence, key competencies, and meta-competencies – highlight the inconsistency that surrounds the concept of competence.

Mansfield (2004:304) in his article, *Competence in Transition*, contrasts three different usages of competence, namely outcomes (vocational standards describing what people need to be able to do in employment); tasks that people do (describing what currently happens); and personal traits or characteristics (describing what people are like).

Apart from the conceptual confusion surrounding competence, terminological confusion also exists in relation to the use of the terms competence, competency and competencies. Whilst some authors use the terms competence and competency interchangeably and treat the two as synonymous, others attempt to discriminate between them. Le Deist and Winterton, whilst conceding that the usages of the two terms are inconsistent, maintain that competence generally refers to functional areas, whereas competency refers to behavioural areas (Le Deist & Winterton 2005:27). Perhaps one of more effectual (and less complicated) distinctions between competence and competency is offered by Woodruffe (1991) in Le Deist and Winterton (2005:29): he contrasts aspects of the job that an individual can perform (areas of competence) with a person's behaviour underpinning competent performance (competency).

Acknowledging the relationship between competence and the context in which it applies only adds to the challenge of developing a single common conceptual framework for competence. Le Deist and Winterton (2005:30-31) are just some of the authors who share the opinion that competences are related to the social and task-specific circumstances (context) within which the event occurs. In their article they refer to several like-minded authors in support of their argument. Authors such as Fischer, Bullock, Rotenberg and Raya (1993) in Le Deist and Winterton (2005:30-31) who contend that people do not have competences independent of context, Sandberg (2000) in Le Deist and Winterton (2005:30-31) who hold that competence is a function of the context in which it is applied, where worker and work form one entity through lived experience of work, Dreyfus and Dreyfus (1986) in Le Deist and Winterton (2005:30-31) who argue that attributes used in accomplishing work are bound to the work context regardless of the level of competence attained, and Velde (1999) in Le Deist and Winterton (2005:30-31) who maintain that competence is constituted by the meaning that the work has for the worker(s). All this is in line with Stoof *et al.* (2002:351) who favour a constructivist approach, whereby a person's situation and needs influence the definition of competence (as it applies to that individual); considering three variables – people, goal and context – will increase the viability of any competence definition (Stoof *et al.* 2002:351).

Another factor contributing to the confusion around the concept of competence involves the influence of different cultural contexts on the understanding of competence (Cseh 2003 in Le Deist & Winterton 2005:30).

<u>Attempts at clarifying the confusion surrounding the concept of competence</u>

In recent history there have been several attempts at clarifying and conceptualising the concept of competence. As early as 1995, Hodkinson and Issitt (1995) in Winterton *et al.* (2006:49) argued for a more holistic approach to competence in the caring professions – one that integrates the knowledge, understanding, values and skills inherent to the practitioner.

Shortly afterwards, Cheetham and Chivers (1996:20-30) published a conceptual paper – *Towards a holistic model of professional competence* – that "describes a model of professional competence which attempts to bring together a number of apparently disparate views of competence".

The competence framework they proposed comprises five domains of interrelated competences and competencies:

- *Cognitive competence* – which includes the underpinning theory and concepts as well as informal tacit knowledge gained experientially.
- *Functional competences* (skills or know-how) – which capture those things that a person should be able to demonstrate.
- *Personal competency* (behavioural competencies or knowledge of how to behave) – which is defined as a "relatively enduring characteristic of a person causally related to effective or superior performance in a job".
- *Ethical competencies* – defined as "the possession of appropriate personal and professional values and the ability to make sound judgements based upon these in work-related situations".
- *Meta-competencies* – these deal with learning, reflection and the ability to cope with uncertainty.

With regard to competencies, Mrowicki (1986), as quoted by Weddel (2006:2), holds that competencies consist of a description of the essential skills, knowledge, attitudes and behaviours required for effective performance of a real-world task or activity. These activities may be related to any domain of life, though have typically been linked to the field of work and to social survival in a new environment. Competencies can therefore be described as a set of behaviours that encompasses skills, knowledge, abilities and personal attributes that, taken together, are critical to successful work accomplishment.

The article, *The Boundary Approach of Competence: A Constructivist Aid for Understanding and Using the Concept of Competence,* highlights the complexities around defining competence. In the article Stoof *et al.* (2002:347) suggest a constructivist approach to competence which, according to the authors, accommodates various definitions of competence. Instead of having to accommodate all possible circumstances within which the term can apply, the definition only needs to prove adequate for the context within which the term applies. Such an approach naturally obviates the pursuit of a one and only true definition of competence: this, in the opinion of the authors, in any case represents a futile endeavour.

Therefore, instead of providing yet another new and improved definition of competence, Stoof *et al.* (2002) propose a theoretical framework (The Boundary Approach), which they describe as a visual and conceptual aid to defining competence within a given context or situation through asking questions and making choices within each dimension (Stoof *et al.* 2002:352). This approach reconciles the meaning of competence with the given needs of a specific situation (Stoof *et al.* 2002:347). The definition of competence is influenced by several dimensions that Stoof *et al.* (2002:352-361) divide into two approaches, namely the *inside-out approach* (which explores the meaning of the concept of competence), and the *outside-in approach* (which focuses on the selection of terms that best express the intended meaning of competence).

The **inside-out approach** contains dimensions of competence. A dimension can be seen as a continuum, flanked by the two opposing extremes of the dimension (for example teachable versus non-teachable competence):

- *Personal versus task characteristics* – personal involves the characteristics of the individual who does the work, as opposed to task characteristics which are about work and achievement, and refer to the essential elements of the task that needs to be fulfilled (Stoof *et al.* 2002:355).
- *Individual versus distributed competence* – competence may apply to an individual or it may be distributed over more than one individual (such as a team working together) – in the latter case (extreme) an individual's competence can no longer be viewed in isolation as competence is now interdependent upon all of the individuals in the group (Stoof *et al.* 2002:355).
- *Specific definitions of competence* (which have a narrow scope) *versus general definitions of competence* (which have a much broader scope) (Stoof *et al.* 2002:356).
- *Levels of competence versus competence as a level* – levels of competence imply gradation and imply that a degree of competence (such as threshold standards and excellent performance); conversely competence may be viewed as one particular level, a delineated stage in the development from novice to expert (Stoof *et al.* 2002:355).
- *Teachable versus non-teachable competence* – which refers to the elements contained within the definition of competence and how easily, if at all, they can be taught (Stoof *et al.* 2002:356).

The **outside-in approach** deals with terms that are related but not equal to competence:

- *Competence versus performance* – not all performance is competent, in that competence requires performance that is at least effective (at a minimum standard); performance is measured in terms of an observable, objective result, whereas competence speaks of the personal abilities that are intrinsic to the result (Stoof *et al.* 2002:358). Gonzi, Hager and Athanasou (1993:6) view performance as that which is directly observable, whereas competence is inferred from performance.
- *Competence versus qualification* – a qualification tends to imply competence, but a competent person is not necessarily qualified (and *vice versa*). Ellström (1998) in Stoof *et al.* (2002:359) views a qualification as a component of competence.
- *Competence versus capability and ability* – these terms are closely linked as all three refer to intrinsic features necessary to complete a task successfully. Stoof *et al.* (2002:359) suggest that whereas competence refers to personal features necessary for successfully completing a task, capability may refer to those personal features of an individual that are not necessarily used, but will allow him/her to successfully complete a task if required (Stoof *et al.* 2002:359). Competence infers ability and capability but not the other way round.
- *Competence versus knowledge, skills and attitudes* – knowledge, skills and attitudes, the terms generally used when defining competence, are essential components of competence but on their own do not constitute competence, and Stoof *et al.* (2002:360) highlight the importance of meta-cognition, defined by the Merriam-Webster Online Dictionary as an awareness or analysis of one's own learning or thinking processes.
- *Competence versus expertise* – competence may be seen to refer to a minimum standard, as opposed to expertise that infers optimal efficiency (but it is not that simple, clearly demonstrated in terms such as 'highly competent' (Stoof *et al.* 2002:360-361).

This approach, whilst maintaining a measure of congruence within a framework of knowledge, skills and attitudes (and meta-competencies or meta-cognition), allows the definition of competence to be customized to the context within which it is being applied.

In their 2005 article, *What Is Competence*?, Le Deist and Winterton (2005:27-46) proposed a typology of competence composed of four interrelated dimensions (Table 2.2):

- competences required for an occupation including both conceptual (cognitive, knowledge and understanding) and operational (functional, psycho-motor and applied skill) competences; and
- competences associated predominantly with individual effectiveness including both conceptual (meta-competence including learning to learn) and operational (social competence including behaviours and attitudes).

Table 2.2 Typology of competence demonstrating the relationship between the four dimensions of competence (adapted from Le Deist and Winterton 2005:39).

	OCCUPATIONAL	**PERSONAL**
CONCEPTUAL	Cognitive competence	Meta-competence
OPERATIONAL	Functional competence	Social competence

Le Deist and Winterton (2005:39) explain that, consistent with the longstanding KSA (knowledge, skills and attitudes) of the training profession, *cognitive competence* encompasses knowledge and understanding; *functional competence* deals with skills and competencies related to behaviour, whilst attitudes are captured by *social competence.* The fourth dimension, *meta-competence*, has to do with an awareness and understanding of one's own intellectual strengths and weaknesses, knowing how to combine knowledge and skills in order to successfully perform tasks, and knowing how to acquire missing competencies (Nelson & Narens 1990 in Winterton *et al.* 2006:33).

In 2008, Albanese, Mejicano, Mullan, Kokotailo & Gruppen published their efforts at identifying the characteristics that define a competency. In the article they compare competencies identified by international medical education organisations such as the Royal College of Physicians and Surgeons of Canada, the Accreditation Council for Graduate Medical Education (ACGME) and American Board of Medical Specialties (ABMS), the Association for Medical Education in Europe (AMEE), and the Institute for International Medical Education (IIME) (Albanese *et al.* 2008:248-255). Arguing that there is still considerable inconsistency in the definitions used to characterise a competency, these authors cite the following definitions taken from the health education literature:

- Competent residents are "able to provide medical care and/or other professional services in accord with practice standards established by members of the profession and in ways that conform to the expectations of society" (Whitcomb 2002:359).
- Competency is described as a "complex set of behaviours built on the components of knowledge, skills, attitudes" and competence is viewed as a "personal ability" (Carraccio *et al.* 2002:362).
- Competencies represent a "set of skills, knowledge and attitudes necessary for the broad practice of public health" (Council on Linkages between Academia and Public Health Practice in Albanese *et al.* 2008:250).
- Competencies are "important observable knowledge, skills and attitudes" (CanMEDS 2005:4).

Although these definitions appear concordant, Albanese *et al.* (2008:250) are quick to point out the substantial variability in the definition of what constitutes a competency. In support of their scepticism of a universal understanding of competence or what constitutes a competency (which implies an inability to define general competencies), the article quotes McGaghie, Miller, Sajid and Telder (1978:23) who argued that because any definition of medical competence is influenced by several variables such as the local political, social and economic circumstances, the structure of the health care system and the availability of resources, an attempt at a universal definition of competence will undoubtedly fail. Rather than promoting a single comprehensive definition of a competency or competencies, Albanese *et al.* (2008:251) propose five characteristics essential to a competency (at least in an instructional context):

- a competency has to focus on the end-product of instruction;
- a competency should reflect the expectations of an instructional process in terms of the *application* of the knowledge acquired during the immediate instructional programme, and not the knowledge itself;
- any competency should be expressible in terms of measurable behaviour;
- a competency has to use a standard for judging independent of the performance of other learners; and

- a competency needs to inform *all* stakeholders with regard to what is expected of them.

They go on to differentiate between outcomes and competencies, contrasting an outcomes model which identifies, defines and communicates the skills and qualities we *want* doctors to have, with a competency model that starts with a focus on what is *needed* from a doctor (*e.g.* with regard to patient care), before deciding on which skills and qualities a doctor should have (Albanese *et al.* 2008:251). A competency model can be seen to focus on the end product of an instructional process rather than the process of instruction – in other words, it captures the bigger picture rather than focusing on the content of a single course. It is easy to see how one can realistically expect a fair amount of commonality (and perhaps confusion) between the two models.

The Definition and Selection of Competencies (DeSeCo) Project

In 1997 the OECD (The Organisation for Economic Co-operation and Development) launched the DeSeCo Project – an acronym for *Definition and Selection of Competencies: Theoretical and Conceptual Foundations*. The project was designed to bring a wide range of expert and stakeholder opinions together in order to produce a coherent and widely shared analysis of which key competencies are necessary for coping with the numerous and varied challenges of today's world.

For his part, German psychologist Franz Weinert (1999) was charged with undertaking a literature review and systematic analysis of existing theoretical and conceptual approaches to competence. During his research Weinert encountered various theoretical approaches to competence. He finds that the term competence does not hold the same meaning in the different contexts within which it is used. He argues that perspectives and the underlying objectives linked to its use (notably in scientific discussion and discussions around policy) continually influence the meaning of the term. In light of the multifarious uses of the term, Weinert (1999:3) therefore concludes that there is no basis for a theoretically grounded definition of competence.

In his report, Weinert suggests that competence and competencies define the intellectual properties necessary for successful cognitive, social and vocational performance. He argues that for a definition of competence to be comprehensive it would need to include learned content-specific knowledge as well as content-free intellectual abilities. This translates into all the "all the intellectual abilities, content-specific knowledge, skills, strategies, metacognitions and action routines that contribute to learning, problem solving and a variety of achievements" (Weinert 1999:26). Weinert (1999) refers to this as a *conditional* approach, which he contrasts with a *functional* approach based on the question: *Which cognitive competencies (conscious intellectual competencies) does one need in order to master tasks and task demands?* He reasons that, answering this question "requires a classification of those demands, problems and tasks for which individuals require special cognitive prerequisites" (Weinert 1999:27). Alluding to curriculum theory, measurement models, and task profiles for most vocations, typical life situations and specific action fields, Weinert (1999) argues that the information we need to determine the conscious intellectual (cognitive) abilities needed to perform well in our school, work and everyday demands, is freely available. The *functional* approach, according to Weinert (1999:27-28), limits the concept of cognitive competence to learned knowledge, skills and corresponding meta-knowledge, and, based on his research, is the approach Weinert recommends.

In 2000 Rychen and Salganik compiled a document, *Definition and Selection of Key Competencies*, in which they report on work that had been undertaken by the DeSeCo Program up until that point. The document deals with the concept of competence (referring to the research undertaken by Franz Weinert in 1999) and identifying key competencies. Accepting that there is no broadly accepted definition or unifying theory as far as the concept of competence is concerned – as concluded by Franz Weinert (1999) – the authors decide on a more pragmatic and conceptual approach to competence and competencies. They associate a competence with the ability to fulfil complex demands and tasks, which

> *"requires not only knowledge and skills but also involves strategies and routines needed to apply the knowledge and skills, as well as appropriate emotions and attitudes, and effective management of these components"* (Rychen & Salganik 2000:8).

In a later paper – the *DeSeCo Symposium Discussion Paper* (Rychen & Salganik 2002:6) – the same authors refer to competencies as inherent qualities embedded within an individual. They point out that competencies are structured around tasks and demands, encompass more than mere knowledge and skills, and can be acquired and developed (Rychen & Salganik 2000:6). These qualities (interrelated attitudes, values, knowledge and skills) can be observed (and measured) during the performance of a complex and demanding action. Therefore, from the observation of a performance, underlying competence may be inferred (Rychen & Salganik 2002:6).

A particular way of interpreting competence involves the concept of key competencies or core skills (Weinert 1999:6). According to Weinert (1999:11) key competencies are context-independent and as such can be applied to a wide variety of different situations in order to ensure good performance (Weinert 1999:14). He holds the following as examples of key competencies:

- *basal competencies* for example mental arithmetic, literacy and general basic education;
- *methodological competencies* such as planning for problem-solving; the competent use of a variety of media e.g. computer skills;
- *communicative competencies* which include (native and foreign) language skills, written and oral elucidation skills; and
- *judgment competencies* such as critical-thinking skills and multidimensional judgments about personal performance of that of others' (Weinert 1999:11).

Looking at Weinert's examples it is plain to see that these competencies are usually at the core of an overall performance, but as Weinert (1999:28) points out, they are no substitute for content-specific knowledge and skills.

Weinert subsequently defines a key competence as:

> *"a central competence upon which (many) others depend; which facilitates understanding and learning [of] a variety of different concepts, rules, principles, strategies, and skills; and which could be applied to solve different problems in different situational contexts"* (Weinert 1999:35).

From their research Rychen and Salganik (2000:12-13) conceptualised key competencies as multidimensional, multifunctional and applicable across different social fields (areas of human existence). The same authors also argue that key competencies refer to "higher order mental complexity", assuming intellectual autonomy. Rychen and Salganik (2000:11-12) subsequently propose the following three generic key competencies: the ability to act autonomously and reflectively (which is dependent upon a consciousness and understanding of one's environment); using tools interactively (the authors use the term in reference to those instruments needed to actively interact with one's environment such as language, knowledge, physical entities etc.); and lastly, joining and functioning in socially heterogeneous groups (described by the authors in terms of the "human dependence on others for material and psychological ends").

Key competencies can therefore be seen as "multifunctional and transdisciplinary competencies that are useful for achieving many important goals, mastering different tasks, and acting in unfamiliar situations" (Weinert 2001 in Rychen & Salganik 2003:53), critical competencies "relevant across different spheres of life" (Rychen & Salganik 2003:53), and "important for all individuals" (Rychen & Salganik 2003:53).

Meta-competencies

In his DeSeCo report, Weinert also refers to meta-competences, suggesting that there is more to competence than just having the knowledge, skills and attitude. Weinert (1999:14) describes meta-competencies as follows:

> *"Metacompetencies make the acquisition of new competencies and the use of available competencies more adaptive and efficient. They refer to knowledge, motivational attributions and volitional skills that allow cognitive resources to be used most efficiently across different tasks, in different content areas, and for different purposes"* (Weinert 1999:14).

In the essay *Toward Understanding Meta-Competence*, Bogo, Katz, Regehr, Logie, Mylopoulos and Tufford (2013:260-261) present a theoretical perspective of holistic competence, consisting of two interrelated dimensions: meta-competence and procedural competence. Meta-competence, according to these authors, "refers to higher order, overarching qualities and abilities of a conceptual, interpersonal and personal/professional nature" which captures a student's cognitive, critical and self-reflective capacities. Procedural competence, on the other hand, has more to do with actual performance. Although there is no clear mention of knowledge, skills and attitudes (inferences are however made), what this perspective highlights is the complex interaction between the traditional competencies of knowledge, skills and attitudes (and behaviour) and the knowledge and insight of how to use these competencies, guided by an understanding of what the situation demands and knowledge of one's competence which comes from critical self-reflection (meta-competence). Reflecting on the event leads to recognition of shortcomings and where improvements can be made (driven by attitudes such as motivation and responsibility), which eventually leads to the attainment of competence or a higher level of competence.

Canadian Medical Education Directions for Specialists (CanMEDS) framework

During the early 1990s, the Royal College of Physicians and Surgeons of Canada (RCPSC) was made aware of a growing concern amongst its fellows about how to best prepare physicians to be effective and truly meet the needs of their patients in the changing health care environment – an environment characterised by patient consumerism, government regulatory encroachment, financial imperatives, medical information on the internet, litigation, technology and the explosion in medical knowledge (Frank & Danoff 2007:642-643). To ensure that physicians were adequately prepared to function in the new health care environment necessitated a reform of medical education – this led to the creation of a Societal Needs Working Group (SNWG) whose goal it was to identify the core competencies that all specialists needed to have in order to meet the needs of society. From the Educating Future Physicians for Ontario (EFPO) project originated the concept of identifying essential behaviours required of physicians, which could then be organised into distinct roles. Subsequent research identified several general competencies required of specialists, which were then grouped into seven major physician roles (*cf.* Table 2.3). The result was the CanMEDS framework (Chemm, Hibbert & Van Deven 2009:135-136).

The original framework was reviewed and updated in 2003, after which the Council adopted the revised CanMEDS framework in 2005. Since its formulation almost two decades ago, the CanMEDS framework has been incorporated into medical curricula worldwide (Frank & Danoff 2007:647). Today it is the rule, rather than the exception, to find a set of physician roles based on the original CanMEDS competencies (for example the six ACGME General Competencies) incorporated into a medical education curriculum.

At the core of the CanMEDS competency framework (Table 2.3) are the skills and qualities that define the abilities of a physician competent in meeting the health care needs of the patients, communities and societies they serve (Frank & Danoff 2007:643). These abilities have been defined in terms of key competencies and have been organised around seven physician roles – thematic groups of competencies embodied by competent physicians. The seven roles are those of medical expert (the central role), communicator, collaborator, health advocate, manager, scholar and professional. The medical expert role is central in the CanMEDS construct as this is the key feature that distinguishes physicians from other professionals. This is also the role that most often is given priority during the medical education process. Providing patient-centred care, however, requires integration of all the CanMEDS roles, together with the application of medical knowledge, skills and professional attitudes.

Each key competency is further defined in terms of enabling competencies – these competencies specify the skills, behaviours and attitudes that the postgraduate learner is expected to display.

Table 2.3 An overview of the CanMEDS 2005 physician competency framework (adapted from Frank and Danoff 2007:644-645) [Table continues on next pages].

Medical Expert Definition: As medical experts, physicians integrate all the CanMEDS Roles, applying medical knowledge, clinical skills and professional attitudes in their provision of patient-centred care. Medical Expert is the central physician role in the CanMEDS framework. Key Competencies: Physicians are able to: • Function effectively as consultants, integrating all the CanMEDS roles to provide optimal, ethical and patient-centred medical care. • Establish and maintain clinical knowledge, skills and attitudes appropriate to their practice. • Perform a complete and appropriate assessment of a patient. • Use preventive and therapeutic interventions effectively. • Demonstrate proficient and appropriate use of procedural skills, both diagnostic and therapeutic. • Seek appropriate consultation from other health professionals, recognizing the limits of their expertise.

Communicator

Definition: As communicators, physicians effectively facilitate the doctor-patient relationship and the dynamic exchanges that occur before, during, and after the medical encounter.

Key Competencies: Physicians are able to:

- Develop rapport, trust and ethical therapeutic relationships with patients and families.
- Accurately elicit and synthesize relevant information and perspectives of patients and families, colleagues and other professionals.
- Accurately convey relevant information and explanations to patients and families, colleagues and other professionals.
- Develop a common understanding on issues, problems and plans with patients and families, colleagues and other professionals to develop a shared plan of care.
- Convey effective oral and written information about a medical encounter.

Collaborator

Definition: As collaborators, physicians effectively work within a healthcare team to achieve optimal patient care.

Key Competencies: Physicians are able to:

- Participate effectively and appropriately in an interprofessional healthcare team.
- Effectively work with other health professionals to prevent, negotiate and resolve interprofessional conflict.

Manager

Definition: As managers, physicians are integral participants in healthcare organizations, organizing sustainable practices, making decisions about allocating resources, and contributing to the effectiveness of the healthcare system.

Key Competencies: Physicians are able to:

- Participate in activities that contribute to the effectiveness of their healthcare organisations and systems.
- Manage their practice and career effectively.
- Allocate finite healthcare resources appropriately.
- Serve in administration and leadership roles, as appropriate.

Health Advocate

Definition: As health advocates, physicians responsibly use their expertise and influence to advance the health and well-being of individual patients, communities and populations.

Key Competencies: Physicians are able to:

- Respond to individual patient health needs and issues as part of patient care.
- Respond to the health needs of the communities that they serve.
- Identify the determinants of health of the populations that they serve.
- Promote the health of individual patients, communities and populations.

Scholar

Definition: As scholars, physicians demonstrate a lifelong commitment to reflective learning, as well as the creation, dissemination, application and translation of medical knowledge.

Key Competencies: Physicians are able to:

- Maintain and enhance professional activities through on-going learning.
- Critically evaluate information and its sources, and apply this appropriately to practice decisions.
- Facilitate the learning of patients, families, students, residents, other health professionals, the public and others, as appropriate.
- Contribute to the creation, dissemination, application and translation of new medical knowledge and practices.

Professional

Definition: As professionals, physicians are committed to the health and well-being of individuals and society through ethical practice, profession-led regulation and high personal standards of behaviour.

Key Competencies: Physicians are able to:

- Demonstrate a commitment to their patients, profession, and society through ethical practice.
- Demonstrate a commitment to their patients, profession, and society through participation in profession-led regulation.
- Demonstrate a commitment to physician health and sustainable practice.

In an effort to set standards for professional competence that encompasses all important domains of professional medical practice, several countries have defined and adopted sets of competencies as a framework for doctor education, certification and maintenance of certification. Table 2.4 lists the competencies (or competency domains) developed by the ACGME, ABMS, the CanMEDS 2005 Project, the Institute for International Medical Education (IIME) (referred to as the 'Global Minimum Essential Requirements') and the Dundee Outcome Model or DOM (referred to as the Learning Outcomes for a Competent and Reflective Practitioner) (Albanese *et al.* 2008:249).

Table 2.4 Competencies identified by various medical education organisations **[Table continues on next page].**

CanMEDS 2005 – Royal College of Physicians and Surgeons of Canada

- medical expert
- communicator
- collaborator

- manager
- health advocate
- scholar
- professional

Global Minimum Essential Requirements – IIME
- professional values, attitudes, behaviour and ethics
- scientific foundation of medicine
- communication skills
- clinical skills
- population health and health systems
- management of information
- critical thinking and research

Dundee Outcome Model – Association for Medical Education in Europe
- clinical skills
- practical procedures
- patient investigation
- patient management
- health promotion and disease prevention
- communication
- medical informatics
- basic, social and clinical sciences and underlying principles
- attitudes, ethical understanding and legal responsibilities
- decision-making skills and clinical reasoning and judgement
- the role of the doctor within the health service
- personal development

Outcomes Project – ACGME and ABMS
- patient care
- medical knowledge
- practice-based learning and improvement
- systems based practice
- professionalism
- interpersonal skills and communication

Conclusion

Amongst all this conceptual confusion and an overriding pessimism in terms of consensus about 'the one and only true meaning of competence', when it comes to defining competence, the researcher finds it appropriate to include the following:

- the possession or mastery of a set of competencies;
- these competencies should include a combination of cognitive, functional, social and meta-competencies;
- the required competencies should be determined by the context in which they apply; and

- the possession or mastery of these required context-specific (and some non-context specific or generic) competencies should enable the individual to perform the task successfully.

2.2.1.2 ***Outcomes-Based Education and Competency-Based Education***

The terms outcomes-based education (OBE) and competency-based education (CBE) describe educational models that are based on the premise that education should be guided by predetermined outcomes. Both focus on the product, as opposed to the process of curricula, and, whilst they differ in detail, any differences between them are subtle (Morcke, Dornan & Eika 2013:856).

For the purpose of this discourse, the researcher follows Morcke *et al.* (2013:851-863) in using the term OBE to refer to both outcomes-based education and competency based education, as well as and standardising on the term *competency* as opposed to *competence* (except when quoting an author who uses the alternative term). This section does not attempt to be a complete treatise on OBE, but merely aims to highlight some of the landmarks in the evolution of OBE.

In 1949, Ralph W. Tyler, an American educator who worked in the field of assessment and evaluation, published his seminal work on *Basic Principles of Curriculum and Instruction*. In it he argues that "the essential purpose of education should be translated into objectives or statements of changes in the learner which could be readily measured", and that "the focus should be on the learner and learner behaviour" (Prideaux 2000:169) – principles similar to those underpinning OBE at present.

The launch of the Russian satellite *Sputnik I* into orbit on 4 October 1957 gave the former Soviet Union the distinction of putting the first human-made object into space; it also created the impetus for the changes that led to the development of OBE (Hodge 2007:182). Harris, Guthrie, Hobart and Lundberg (1995:37) in Hodge (2007:182) report that the immediate reaction of the United States was to "undertake some deep soul searching with respect to its education and training system". Hodge (2007:183) puts it into perspective:

> *"After all, if Soviet Union technology was more advanced than America's, then the very foundation upon which American technological superiority was supposed to rest – its education system – was obviously the source of the problem"* (Hodge 2007:183).

American society held the educational system accountable for the USA falling behind in the space race, with the ensuing debate and research igniting the development of OBE. This initial theoretical orientation of OBE, Morcke *et al.* (2013:852) assert, was towards behaviourism and grounded in a focus on observable behaviours.

During the years spanning 1948 to 1953 a group of educational psychologists, chaired by psychologist Dr Benjamin Bloom, undertook the task of classifying educational goals and objectives (statements of what learners are expected to have learnt by the end of their period of instruction). "Their intent was to develop a method of classification for thinking behaviours that were believed to be important in the processes of learning" (Forehand 2005:Online). Bloom, Tyler and their colleagues eventually developed a classification or taxonomy consisting of three domains that would become known as *Bloom's Taxonomy of Learning Domains* (or Bloom's Taxonomy of Educational Objectives). The three domains are *cognitive* (knowledge-based domain consisting of six levels) – involves knowledge and the development of intellectual skills; *affective* (attitude-based domain consisting of five levels) – involves the manner in which we deal with things emotionally such as feelings, values, appreciation, enthusiasm, motivations, and attitudes; and *psychomotor* (skills-based domain consisting of six levels) – involves physical movement, coordination, and use of the motor-skill areas.

In 1968, Bloom published his approach to learning for mastery in which he recommended the development of performance standards and the organisation of education in such a manner as to allow the majority of students to attain these standards (Bloom 1968:9). Bloom refers to the specification of objectives and content of instruction as necessary preconditions in the development of mastery learning. He contends that the specification of these parameters informs both teachers and students about the educational expectations (Bloom 1968:8), and opines that assessment based on these specified parameters informs students as to what they should be able to do at the end of the instructional period. Such assessment also has the potential to inform both student and teacher whether the process of teaching has been effective (Bloom 1968:8).

Eight years after the group first began its ambitious task, work on the cognitive domain was completed and in 1956 the first part of the taxonomy was published. This first part, *Taxonomy of educational objectives: The classification of educational goals. Handbook I: The cognitive domain* (Bloom, Engelhart, Furst, Hill & Krathwohl 1956), focused, as the title suggests, on the cognitive domain. The second instalment – *Taxonomy of Educational Objectives: The classification of educational goals. Handbook II: The affective domain* (Krathwohl, Bloom & Masia 1964), published eight years later – dealt with the affective domain. Bloom did not, however, produce a taxonomy for the third domain (Dent & Harden 2009:19), resulting in various other people contributing to the psychomotor domain – the three most popularly referenced versions of the psychomotor domain are those by Dave (1967/70), Harrow (1972) and Simpson (1966/72) in Chapman (2006:Online).

All three domains feature several levels of increasing complexity. The attainment of each level assumes the attainment of the lower levels with each level subsumed by the higher levels. Over the years Bloom's Taxonomy has been revised and expanded, with the most notable and recent work being that by Anderson, Krathwohl and Bloom (2001) – *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (2001) and Krathwohl (2002) – *A Revision of Bloom's Taxonomy: An overview*.

Table 2.5 A summary of the educational objectives that constitute each of the three domains that make up Blooms taxonomy – arranged according to increasing levels of difficulty (progression to a higher level presupposes mastery of the present level and all lower levels (adapted from Chapman 2006:Online) [Table continues on next page].

AFFECTIVE DOMAIN	**COGNITIVE DOMAIN (original)**	**PSYCHOMOTOR DOMAIN (Simpson's)**
Deals with a learner's interest, attitudes and values	Deals with knowledge and the development of intellectual abilities and skills	Deals with motor skills
Receiving (willingness to receive - awareness)	**Knowledge** (recall or recognise information)	**Perception** (awareness)

Responding (willingness to respond - participate actively)	**Comprehension** (understand meaning)	**Set** (readiness to act)
Valuing (attach values and express personal opinions)	**Application** (use or apply acquired knowledge)	**Guided response** (attempt)
Organisation of values (develop a value system)	**Analysis** (interpret elements, relationships and organisational principles)	**Mechanism** (basic proficiency)
Characterisation or internalisation of values (adopt a belief system)	**Synthesis** create / build (creative thinking)	**Complex overt response** (expert proficiency)
	Evaluation (judgement in relation to internal evidence and external criteria)	**Adaptation** (adaptable proficiency)
	Analysis (Structure /elements)	**Origination** (creative proficiency)

In the early 1960s, public discourse about the crisis in American education expanded to include the teacher education programmes, with authors such as Conant (1963) and Korner (1963) criticising instruction in the existing teacher education programmes for not being tailored to individual requirements and that outcomes were not being evaluated (Norton, Harrington & Gill 1978:8 in Hodge 2007:184).

In 1965, the United States government responded with the Elementary and Secondary Education Act that, among other objectives, promoted research into the improvement of teacher education programmes. According to Hodge (2007:184) a deciding event in the development of OBE came in 1968, when Comprehensive Elementary Teacher Education Models, developed in response to a call for tenders by the United States Office of Education's (USOE) National Centre for Educational Research, were characterised by "the precise specification of competencies or behaviours to be learned, the modularisation of instruction, evaluation and feedback, personalisation, and field experience" (Swancheck & Campbell 1981 in Hodge 2007:184).

Early 1970 saw the inception of the aptly named *Performance-Based Teacher Education* (PBTE) movement, which sought to clarify problems and concepts related to performance-based teacher education (Hodge 2007:186). In 1971, one of the influential contributors to this effort, the *Committee on Performance-Based Teacher Education* (established by the American Association of Colleges for Teacher Education [AACTE]) released the first in a line of publications aimed at assisting practitioners in schools, colleges and universities. Within the pages of these documents, the Committee on Performance-Based Teacher Education undertook to elucidate key concepts central to the PBTE movement (Elam 1971:iv). In his state-of-the-art paper, *Performance-based teacher education: What is the state of the art?* Elam (1971:6-7) describes the characteristics that render a teacher education programme performance-based (according to the AACTE definition of a PBTE programme). Table 2:6 gives a summary of these characteristics inherent in a performance-based teacher education programme.

Table 2.6 Characteristics inherent in a performance-based teacher education programme as defined by the AACTE (compiled from Hodge 2007:186-187).

Competencies (knowledge, skills and behaviours) to be demonstrated by the student are: • derived from explicit conceptions of teacher roles, • stated so as to make possible assessment of a student's behaviour in relation to specific competencies, and • made public in advance.
Criteria to be employed in assessing competencies are: • based upon, and in harmony with, • specified competencies, • explicit in stating expected levels of mastery under specified conditions, and • made public in advance.
Assessment of the student's competency: • uses performance as the primary source of evidence, • takes into account evidence of the student's knowledge relevant to planning for, (analysing), interpreting, or evaluating situations or behaviour, and • strives for objectivity.
The student's rate of progress through the programme is determined by demonstrated competency rather than by time or course completion.
The instructional programme is intended to facilitate the development and evaluation of the student's achievement of competencies specified.

The mid-seventies saw a period of negativity towards the behavioural objectives curriculum model (Morcke *et al.* 2013:852). One of the influential OBE critics of the time, Stenhouse (1975), disagreed that defining outcomes "in terms of measurable changes in student behaviour" was the only way to organise a curriculum (Morcke *et al.* 2013:852-853). Stenhouse (1975) argues that whilst learning objectives for factual knowledge and simple skills made good sense, it is not possible to specify goals or assess objectively educational processes that influence the development of values, insight and judgement (Morcke *et al.* 2013:853). Stenhouse's argument, Morcke *et al.* (2013:853) assert, translates into an emphasis on optimising student learning as opposed to measuring outputs or outcomes.

At the beginning of 1980, following years of negativity towards the behavioural objectives curriculum model during the late 1970s, OBE experienced a revival, spearheaded by sociologist William G. Spady – regarded widely as the world authority on OBE (Killen 2000:2). Killen (2000:2) argues that Spady (1994) conceptualises OBE as an *approach* to tuition that focuses all relevant processes (the planning, delivering and evaluation of teaching) and everyone involved (administrators, teachers and students) on the desired results of education.

> *"Outcome-Based Education means clearly focusing and organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences. This means starting with a clear picture of what is important for students to be able to do, then organizing the curriculum, instruction, and assessment to make sure this learning ultimately happens"* (Spady 1994:1).

Killen (2000:2) contends that the success of such an approach depends not only on being able to determine the outcomes (knowledge, understanding, skills and attitude) that is essential for students to acquire, but also accepts that it is possible to achieve the desired end result through the appropriate organisation of the educational system and proper classroom practices (Killen 2000:2).

Whilst adhering closely to the earlier behaviourist principles of the competency movement, Spady (1994) does not view factors (affects) such as attitudes, emotions and values, as learning outcomes in their own right (Spady 1994:55-60). Whilst he acknowledges the importance of these psychological and affective attributes – inherent in any performance – and the role these factors play in the demonstration of an outcome, he argues that they are not directly observable and instead refers to these attributes as goals (Spady 1994:55-57).

During a conversation with Ron Brandt (1992/1993:66-70), Spady defined OBE in terms of the following four principles:

Clarity of focus: Clarity of focus requires all curricular design, all instructional delivery (teaching) and all assessment design to centre on what learners are expected to do successfully by the end of the instructional period. Spady asserts that all students should have clarity about the goals of their learning process. They should also be informed of the criteria that will be used to assess their performance and remain cognisant of their own performance in relation to each of those goals (Spady 1988:7).

Expanded opportunity: Expanded opportunity is based on the premise that intellectual quality is not reserved for a select few and that most students, given the opportunity, can achieve high standards (Killen 2000:3-4). According to Spady (1992) in Brandt (1992/1993:66) students should be informed, at a very high level, of what they are expected to learn; hereafter the challenge lies in providing the student with the appropriate opportunities to achieve that level.

High expectations: High Expectations means expecting all students to achieve, not just a select few. Spady (1992) in Brandt (1992/1993:66) refers to bell curve standards and expectations.

Design down: In design down, Killen (2000:3) explains, the design of a curriculum starts with the identification and definition of the learning outcomes expected of a student by the end of his/her instructional period (their formal education). From this point onwards, all curriculum, instructional and assessment decisions are made in accordance with the desired end result.

Killen (2000:4) asserts that only where all four these principles are inherent in an educational system can it justifiably claim to provide outcomes-based education. According to Killen (2000:2-3) these four principles are based on three premises that form the basis of OBE. These premises hold that all students can learn and succeed (although not necessarily at the same pace or in the same way) and that successful learning will lead to even more successful learning. It also places the schools and teachers in control of the conditions that will ultimately determine a student's success at school learning.

Several important events during the late 1990s added impetus to the acceptance and implementation of OBE. In 1998, the *Medical School Objectives Project (MSOP)* – an *AAMC (Association of American Medical Colleges)* initiative designed to reach general consensus within the medical education community on the attributes (skills, attitudes and knowledge) that medical students should possess at the time of graduation – produced a report advocating competency-based education (AAMC 1998:1-13).

In 1998, Neufeld, Maudsley, Pickering, Turnbull, Weston, Brown and Simpson published the groundbreaking *Educating Future Physicians for Ontario Project (EFPOP)*, which sparked the development of the CanMEDS competency framework (*cf.* page 34).

In 1998, the *Accreditation Council for Graduate Medical Education (ACGME)* launched an initiative called the *Outcome Project*, hoping to link competency-related education, improvements in resident performance and better patient care. In the words of Swing (2007:648) this project "seeks changes in residency programs that focus education on the competency domains, enhance assessment of resident performance and increase utilization of educational outcomes for improving residents' education". The six domains of general competencies – patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism and systems-based practice – were identified jointly by the ACGME and American Board of Medical Specialties (ABMS) in 1999 (Swing 2007:648-650).

In 1999, *The Association for Medical Education in Europe (AMEE)* published a five-part series on OBE, simply referred to as *AMEE Guide 14: Outcome-Based Education*. The AMEE's Education Guides are designed as practical, how-to-do-it guides on important topics such as problem-based learning, outcomes-based education, portfolios in student assessment and a wide range of other topics. In Part 1 Harden, Crosby and Davis (1999:7) refer to OBE, as "an approach to education in which decisions about the curriculum are driven by the outcomes the students should display by the end of the course". They view OBE as an insightful new approach to medical education that focuses on the product – the characteristics of the qualified doctor – rather than on the process of education (Harden *et al.* 1999:7); a case of product defining the process.

According to Harden *et al.* (1999:7), OBE has two requirements: The first requirement involves the identification and explicit definition of all learning outcomes, followed by the communication of these outcomes to all stakeholders (including the students and teachers); the second requirement demands that these learning outcomes dictate any decision about the curriculum. In the same article the authors identify the following advantages of OBE (Harden *et al.* 1999:9-10):

- *Relevance* – outcomes-based education models emphasise the relationship between the curriculum and the actual practice of medicine. Through the specification of outcomes, previously neglected areas are attended to, and by specifying the level of study it encourages higher levels of learning.
- *Controversy* – outcomes-based education addresses issues such as the type or quality of doctors we are training or that we need to train.
- *Acceptability* – according to Harden *et al*. (1999:9), OBE is teacher friendly and readily acceptable to most teachers.
- *Clarity* – the concept is unambiguous and easy to understand.
- *Provision of framework* – the OBE model incorporates outcomes and integrates teaching, learning and assessment, thereby providing a robust framework for a curriculum.
- *Accountability* – through explicitly defined outcomes against which performance can be judged.
- *Self-directed learning* – the process provides students with an educational framework, which encourages them to take responsibility for and control of their learning.
- *Flexibility* – OBE specifies outcomes but does not dictate instructional delivery.
- *Guide for assessment* – by specifying the level and content of learning outcomes, OBE provides a framework for assessment.
- *Participation in curriculum planning* – according to Harden *et al*. (1999:9), this approach favours widespread participation in the development of a curriculum.
- *Tool for curriculum evaluation* – outcomes provide the criterion for judgement of the curriculum.
- *Continuity of education* – facilitated through the specification of outcomes for the different stages of education.

In 2010, an influential report by Cooke, Irby and O'Brien, *Educating physicians: A call for reform of medical school and residency*, identified a relationship between a general failure to specify outcomes for medical education programmes, and the public's concern about the competence of medical graduates and subsequently the safety of patients (Morcke *et al.* 2013:854). The document endorses a competency-based approach to curriculum development and recommended widespread adoption of OBE. The report also highlights the importance of assessment, which in the words of the authors, "had to cover professional formation as well as formal knowledge and clinical performance, and include formative feedback, guidance and mentoring as well as summative certification of competence at each level of development" (Morcke *et al.* 2013:854). Notwithstanding a strong advocacy of OBE, the report draws attention to the problem of defining and assessing affective elements of professionalism such as humanism, accountability and altruism. Morcke *et al.* (2013:854) are quick to point out the link to a similar concern raised by Stenhouse (1975) over 30 years earlier - a concern that Spady (1994) circumvented by precluding affective elements from outcomes used in the design of curricula.

In *An introduction to outcome-based education* (Part 1 of the AMEE Guide on Outcome-based education) Harden *et al.* (1999:8) argue that whilst OBE may be easy to conceptualise, it is difficult to define. In OBE teaching and assessment is guided by the learning outcomes as held by the curriculum.

> *"The educational outcomes are clearly specified and decisions about the content and how it is organised, the educational strategies, the teaching methods, the assessment procedures and the educational environment are made in the context of the stated learning outcomes"* (Harden *et al*. 1999:8).

Once outcomes have been identified, stated clearly (and in detail), and communicated to all role players, they lay the platform for accountability. Amid the increasing calls for accountability and transparency in education (both at compulsory and non-compulsory levels), it is perhaps this characteristic more than any other, which has contributed to the rapid spread of OBE in countries such as the United States, United Kingdom and Australia (Killen 2000:1).

Whilst OBE almost certainly has a lot to offer in terms of curriculum design, assessment, student learning and accountability, the literature proffers several concerns and criticisms. In the article, *The trouble with learning outcomes*, Hussey and Smith (2002:222) raise concern about the way learning outcomes have been misappropriated for managerial purposes. They refer to two major transformations that have taken place in education; first, education has become a commodity, and second, the process of education had to become transparent, capable of being monitored, audited and evaluated (Hussey & Smith 2002:221). These changes – at least the latter – can be seen as a response to the increasing emphasis on transparency and accountability in education. Learning outcomes have become essential to the commodification of learning, and with commodification come the demand for auditing and monitoring of the performance of those involved. Hussey and Smith (2002:231) therefore warn that learning outcomes are in danger of becoming mere instruments, used in the monitoring of the educational process.

> *"Their alleged explicit clarity, precision and objectivity are largely spurious. Those academics and teachers who have had to use them have overcome this vacuity either by merely feigning compliance or by implicitly (and perhaps even unconsciously) interpreting them in terms of their existing knowledge and experience. The managers who have insisted upon them, generally in response to the demands of outside agencies, have either not understood them well enough to notice their emptiness, or they too have unwittingly interpreted their meaning in the light of their knowledge of the subjects concerned. We have also argued that even where they are given content, their effects may be undesirable in educational terms"* (Hussey & Smith 2002:232).

Conceding that there are benefits in specifying expected outcomes (theoretical knowledge and general skills students are expected to learn), Hussey and Smith (2002:228) warn that the utilisation of learning outcomes as precise prescriptions (that have to be spelled out before teaching can begin), may stifle emergent learning outcomes that may be beneficial to a student's learning experience. In doing so they propose a more flexible and practical way of interpreting learning outcomes that should "emerge from the context and prevailing activities and experiences of the student" (Hussey & Smith 2002:232).

Talbot (2004) raises another concern: Referring to graduate medical education in the United Kingdom, he criticises the competency model for having a "tendency to limit the reflection, intuition, experience and higher order competence necessary for expert, holistic or well-developed practice" (Talbot 2004:587). Reminding us of how difficult, if not impossible, it is to define and assess inherent skills such as decision-making, response to events as they occur, attitude towards patients, etc. he expresses concern about a behaviourist competence-based model which, in an attempt to be transparent and accountable, neglects personal values and values such as responsibility and reflection (Talbot 2004:591). This argument is implicit in his question: "How do we ensure that our neophyte practitioner possesses the competence safely to perform assigned tasks, and yet elaborates an intuitive knowing that 'senses the wider picture'?" (Talbot 2004:591).

Hodges (2010) raises another interesting point. He reminds us that for many years we have relied on time-based models of medical education where time determined competence (once a student has completed the training period it is assumed that he/she is competent). He contends that adopting outcomes-based models may well lead to shortening of training periods – in other words, the attainment of outcomes determines competence irrespective of time. Whilst acknowledging the merits of an outcomes-based model, he argues that some elements of personal development require time to develop and warns that we should not be too eager to substitute time for outcomes; not without further investigating whether cognitive structures, problem-solving routines, pattern recognition, judgment and reflective capacity (to name but a few) can be successfully modularised (Hodges 2010:s43).

> *"Assessment of competence has always been a problem in the time-based models. In-training assessment is riddled with subjectivity, validity problems, and low numbers of observations, meaning that hard decisions are often deferred to end-of-rotation, end-of-year, or even end-of-program high-stakes examinations"* (Hodges 2010:38).

From the literature it is clear that OBE is a concept that means different things to different people. In an attempt to clarify the concept of OBE and in order to proffer an inclusive definition of OBE, Frank, Mungroo, Ahmed, Wang, de Rossi and Horsley (2010) conducted a comprehensive inquiry of the scholarly sources related to OBE. They identified several recurring themes that they believed form the fundamental concepts of the competency-based approach (Frank, Mungroo, Ahmed, Wang, de Rossi & Horsley 2010:633).

The following are just some of the concepts (adapted from Frank *et al.* 2010:635):

- OBE represents a distinct approach to education because of its dedication to predefined graduate abilities as the organizing principle.
- The identification of specific competencies aligned to the outcomes of a training programme: These outcomes are derived from the abilities required of physicians for practice or to meet the standards of the profession.
- Curricula that are structured around the identified competencies: The curriculum node includes references to learning strategies, teaching methods and instructional design.
- The need for the components of competency-based education: These should be observable and comparable to objective criteria for all learners.
- Progression of competence, which is implicated in the assessment of pre-defined standards or milestones that indicate progress toward the defined outcomes of a curriculum. Assessment is criterion-referenced, in that learners are measured against set standards and not against other learners.

From these concepts around the organising framework of OBE, as well as discussion about the use of OBE to ensure that curricula are aligned with the learning needs of diverse medical learners, the need for OBE to ensure that graduates have the essential abilities to effectively serve patients and populations once in practice, and from discussions that contrast time-based medical education designs with OBE, Frank *et al.* (2010) constructed the following 21st century definition of OBE:

> *"Competency-based education (CBE) is an approach to preparing physicians for practice that is fundamentally oriented to graduate outcome abilities and organized around competencies derived from an analysis of societal and patient needs. It deemphasizes time-based training and promises greater accountability, flexibility, and learner centeredness"* (Frank *et al.* 2010:636).

2.2.2 Changes to Curricular Content for Postgraduate Radiology Training

A curriculum should state the aims, objectives, content, outcomes and processes of the training programme. Modern competency- and outcomes-based postgraduate curricula include generic elements related to 'medical professionalism' (such as the

CanMEDS principles or the GMC's 'Good Medical Practice' criteria), as well as other specialty-specific subject matter and educational components. In the past number of years, postgraduate radiology curricula have been under review in all the major English-speaking countries, including the USA, United Kingdom, Australia and New Zealand.

2.2.2.1 *Revised Curriculum of the American Board of Radiology (ABR) – United States of America*

Changes to the American Board of Radiology (ABR) examination plan – most notably the development and implementation of the Exam of the Future (EOF) – has prompted widespread changes to radiology training in the United States. As from July 2010, the American Radiology Residency Programme comprises a clinical year or postgraduate year, followed by four years of postgraduate radiology training (residency). During the first three years of core radiology rotations, all residents are exposed to the nine different subspecialties and get a similar breadth of experience. The curriculum for these first three years, the Core Curriculum, serves as a study guide in preparation of the Core Examination, which is scheduled for 36 months after initiation of residency. The curriculum deals with anatomy, pathophysiology and physics concepts important for the practice of diagnostic radiology. In terms of diagnostic radiology, it contains detailed information on what the candidate is expected to know, divided according to various subspecialties (breast imaging, cardiac imaging, gastro-intestinal imaging, interventional radiology, musculoskeletal imaging, neuroradiology, nuclear radiology, paediatric radiology, reproductive and endocrine imaging, thoracic imaging, urinary imaging and vascular imaging). Within each of these categories, reference is made to any or all of the following (as applicable) (ABR 2014a:5-129): imaging techniques including ultrasound, magnetic resonance imaging (MRI), computed tomography (CT), nuclear medicine and/or radiography/ fluoroscopy; procedures; normal anatomy including variants; relevant physiology; relevant pathology; and radiation considerations. Ultrasound and Physics are dealt with separately.

Under the heading of Quality and Safety (ABR 2014a:95), the study guide deals with principles related to general quality improvement and patient safety in radiology – this includes the six Core Competencies as established by the ACGME (Accreditation Council for Graduate Medical Education) namely patient care, medical knowledge, interpersonal and communication skills, professionalism, practice-based learning and improvement, and systems-based practice. This section of the study guide further deals with practical applications of patient safety which include periprocedural care, MR safety, contrast safety, as well as radiation safety and dose optimisation (ABR 2014b:25-42).

Specific programme requirements, written by the ACGME Diagnostic Radiology Residency Review Committee, require the curriculum to contain the following educational components (ACGME 2008:10-11): overall educational goals for the programme; competency-based goals and objectives for each assignment at each educational level; regularly scheduled didactic sessions; and ACGME core competencies.

During the fourth year, the residents choose one, two or three subspecialty rotations depending on their interest, the number of residents and the available subspecialty rotations (Rumack 2011:127). Hereafter, the resident has the option of either working in a radiology practice or spending one to two years in a fellowship programme. The final examination, or Certifying Exam, must be taken 15 months after completion of residency (Rumack 2011:131).

Although there is no mention of continuous assessment or workplace-based assessment in the Core Exam study guide or the American Board of Radiology (ABR) website, educational programme and resident evaluation guidelines are provided in the programme requirements written by the ACGME Diagnostic Radiology Residency Review Committee. In terms of formative assessment, the programme has to comply with the following (ACGME 2008:18): assessments have to be objective; residents are assessed in terms of competence in patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice; assessments require the use of multiple assessors; and following assessment, the fellow should receive feedback on his or her assessment.

Summative assessment is reserved for the final period of education, when a student has to demonstrate sufficient competence, before being allowed to practise without direct supervision (ACGME 2008:18).

2.2.2.2 *Revised Curriculum of the Royal College of Radiology (RCR) – United Kingdom*

The new 2012 RCR (Royal College of Radiologists) Specialty Training Curriculum for Clinical Radiology (updated May 2012 and considered a revision of the 2010 curriculum rather than a new version) defines the process of training and the competencies needed for the successful completion of training in clinical radiology (RCR 2012:4). Although the curriculum is competency-based (acknowledging the fact that learning occurs at different rates), radiology training spans five years of full-time training, which can be subdivided into three years of core training and two years of special interest training. The curriculum identifies three levels of training: core, level one and level two. Core training takes place during the first three years with competence reflecting what is likely to be required by any radiologist performing acute imaging (RCR 2012:12). Level one and two training occurs during the fourth and fifth years of the training programme. Level one competence reflects independent practice as a consultant with level one competence in at least two areas of special interest, whilst level two competences reflect expert practice and applies to a radiologist with expertise in one or possibly two areas of special interest.

The curriculum identifies competencies and learning outcomes related to good general clinical practice as well as those specific to clinical radiology. Aims of the curriculum, learning objectives and syllabus content for physics and anatomy are described in detail. As for the generic content (behaviours in the workplace, good clinical care, managing long-term conditions, infection control, patient safety with clinical governance, leadership/ management development, ethical and legal issues, teaching and training and maintaining good medical practice), knowledge, skills and behaviours are described for each subdivision, with expected competencies listed according to the three levels of training. The radiology-specific content is subdivided into fifteen categories (breast imaging, cardiac imaging, emergency imaging, gastro-intestinal imaging, head and neck imaging, musculoskeletal imaging, oncological imaging, paediatric imaging, thoracic imaging, uro-gynaecological imaging, vascular and neuroradiology, as well as academic radiology, radionuclide radiology and radiology procedural skills) with the requisite knowledge, skills and behaviours described according to the level of training (RCR 2012:67-150).

Both summative (examinations) and formative (workplace-based) assessments are integrated into the curriculum. Whilst both forms of assessment are used to judge performance, formative workplace-based assessments are the basis of much of the assessment of generic skills and competencies, such as good medical practice, clinical care, professionalism and leadership. Some of the workplace-based assessments are radiology specific (mini-IPX and Rad-DOPS), whilst others, such as Audit Assessment, Teaching Observation and Multi-Source Feedback are more generic. These assessment tools, according to the curriculum, are designed to help doctors develop and improve their performance with feedback being the key factor. An online ePortfolio stores all the evidence required to demonstrate the satisfactory (or otherwise) progression of a trainee thorough the training programme and thus provides a record of objective evidence of competence and satisfactory performance (RCR 2012:5).

Fellowship of the Royal College of Radiologists (FRCR) may be obtained by examination after three years of full-time clinical radiology training. Applicants only need to hold a formal clinical radiology training post, in which they are actively receiving clinical radiology training, in order to enter the First FRCR Examination. There is no requirement to have completed a specific duration of training. Having passed the First FRCR Examination, a candidate may attempt the Final FRCR Part A Examination – again there is no requirement to have completed a specific duration of training. Candidates who have passed the Final FRCR Part A Examination are then permitted to enter the Final FRCR Part B Examination upon completion of three years of formal clinical radiology training (summarised from the Regulations for the Examinations for the Fellowship of the Royal College of Radiologists in Clinical Radiology [RCR 2014a:Online]).

2.2.2.3 *Revised Curriculum of the Royal Australian and New Zealand College of Radiology (RANZCR) – Australia and New Zealand*

The new RANZCR (Royal Australian and New Zealand College of Radiologists) Radiodiagnosis Curriculum, introduced December 2009, outlines the structure of the diagnostic radiology training programme, the knowledge and skills that the College expects radiology trainees to develop, and the nature of various examinations and assessments that should occur throughout the training programme. As such, the goals of the new radiology curriculum are to provide a training programme that uses educational best practice and to provide direction (a road map) to help trainees acquire the necessary competencies during their five years of training (RANZCR 2009a:7). The five-year training programme consists of two phases. Phase One comprises three years' general radiology training, whilst Phase Two consists of two years' systems-focused rotations for advanced radiology training (RANZCR 2014:15).

The curriculum identifies seven roles (based on the CanMEDS roles), consisting of a medical expert and six non-medical expert roles, which it believes encompasses the competencies of the specialty. Within the medical expert role the curriculum includes syllabi for key conditions in early training, patient safety, report writing, applied imaging technology, radiological anatomy and normal variants, pathology and radiodiagnosis of specific body systems. The required skills and learning objectives, essential to each category, are contained within each syllabus. Conditions within each core syllabus have been divided into three categories of knowledge with category one representing "must know" knowledge, category two "important to know" knowledge and category three "useful to know" knowledge (RANZCR 2014:15).

Applied imaging technology deals with the physical principles of image acquisition; image processing and image display, as these apply to the various imaging modalities, namely magnetic resonance imaging, computed tomography, fluoroscopy, mammography, ultrasound and nuclear medicine. Specific attention is also given to the impact on patient safety and image quality. The body-systems syllabus defines the learning competencies, the clinical conditions and normal variants for each body system (abdominal imaging, chest imaging, musculoskeletal imaging, paediatric imaging, breast imaging, head and neck imaging, neuroimaging, obstetric and gynaecological imaging, as well as vascular imaging and interventional radiology) with reference to the various (appropriate) imaging modalities and radiological interventions (where applicable) (RANZCR 2014:112).

The six non-medical roles are based on the CanMEDS roles and include:

- communication skills (communicator);
- teamwork (collaborator);
- management and administrative skills (manager);
- patient support and advocacy (health advocate);
- research and education (scholar); and
- professionalism (professional).

The curriculum utilises a range of assessment methods to be employed on multiple occasions throughout all phases of training, with the aim of providing timely feedback and guidance to trainees. These assessment tools include logbooks, MSF (Multi-Source Feedback), DOPS (Direct Observation of Procedural Skills), Mini-IPX (Mini-Individual Patient Exercise), CATs (Evidence-Based Radiology and Critically Appraised Topics) and two projects. Requirements for training based on experience and observation (experiential training) have been developed for general x-ray (radiography/ fluoroscopy), breast imaging, interventional radiology, magnetic resonance imaging, nuclear medicine, paediatrics/neonatal imaging and obstetrics and gynaecological imaging. Trainees are required to document the period of time spent in experiential training and record the number of examinations/procedures performed (RANZCR 2014:14).

During the course of the training programme a candidate is expected to pass two major examinations. All components of the Part 1 examination must be passed within the first two years of training. To qualify for the Part 2 examination, a candidate must have passed the Part 1 examination, completed at least three years of accredited training and have completed all in-training assessments and portfolio requirements for phase one of training (RANZCR 2009a:27).

2.2.3 An Overview of Relevant Concepts in Educational Assessment

Assessment of student learning is an integral part of the teaching-learning process, and concepts of assessment that have a bearing on this study need to be elucidated.

> *"Assessment attempts to fulfil a number of important functions. These include encouraging students to work, measuring the level of student understanding or attainment, ranking students, and providing feedback to both students and staff as to how they are performing. The outcome of the assessment also depends upon a range of factors, including student effort, student ability, the quality of the teaching, the design of the assessment, and the implementation of the assessment procedure"* (McLachlan & Whiten 2000:788).

2.2.3.1 *Assessment in Education*

The literature on assessment is extensive and views expressed often are at variance. In recognition of the different conceptual views on assessment, discordant opinions are suitably referenced.

The first issue regarding assessment, which necessitates clarification, is the use of the terms *evaluation* and *assessment.* Although the literature draws a distinction between the two terms (see below), many authors, whilst acknowledging the difference, use the terms interchangeably. In this literary work the term assessment is preferred and will be used to refer to the process required to effectuate judgement; where referenced work prefers the term *evaluation*, it should be taken to refer to the same process as assessment (unless stated differently).

The Oxford Dictionary (2014a:Online) defines *evaluation* as the making of a judgement about the amount, number, or value of something; assessment (the dictionary equates evaluation to assessment). In Taras' (2010:124) opinion, *evaluation* covers a macro spectrum, which includes universities, courses and documentation of programmes; *assessment,* on the other hand, covers a micro spectrum, which involves the assessment of individual students' work. This distinction, essentially one of context, applies predominantly to the United Kingdom. United States' academics, however, use evaluation in the sense of assessment as described above (Taras 2005:467).

Assessment is a natural phenomenon and forms an integral part of our daily life. In terms of education, assessment forms an integral part of the triumvirate of assessing, learning and teaching (Taras 2010:123). Rowntree (1987:4) explains that assessment in education can be seen as an interaction, direct or indirect, aimed at obtaining information that can be interpreted in order to provide insight about a student's knowledge, understanding, abilities and attitude. Also consider Popham's definition of educational assessment:

> *"Educational assessment refers to the process by which teachers use learners' responses to specially created or naturally-occurring stimuli to draw inferences about the learners' knowledge and skills"* (Popham 2006:4).

Writing about the impact of classroom assessment on students, Crooks (1988:467) reminds us of assessment's considerable ability to influence education. Assessment can influence students in various ways; for instance, it influences the way they study – which in turn affects the development of long-lasting learning strategies and skills; it influences (often dictates) what they study; it influences their perception of competence, and it can both motivate and discourage (Crooks 1988:467).

Definitions and Characteristics

Assessment constitutes a single but complex process. The result of this process is a judgement that can be compared to a criterion. A judgement can be many things: It can be formal or informal, either implicit or explicit, of a process or a product, or anything in between (Taras 2010:125).

Epstein (2007:388) states that assessment either may be summative or formative. He holds that summative assessment judges overall competence and documents performance which in turn determines fitness to practise or advancement to higher levels of responsibility. Formative assessment, on the other hand, provides insight, promotes reflection and guides future learning.

Michael Scriven (1967) is widely credited with being the first to use the terms formative and summative assessment (Taras 2005:466; Wiliam & Black 1996:537), using the terms to qualify the different roles that assessment might play in the context of curricular evaluation and improvement (Heritage 2010:18). Scriven (1967:41-42) claimed that the summative role of assessment enabled administrators to judge the quality of the finished curriculum – occurring at the end. The formative role of assessment engages the process, and allows administrators to make on-going improvements to the curriculum – it therefore contributes to the ongoing improvement of the curriculum (Scriven 1967:41).

Two years later Benjamin Bloom applied the concepts of formative and summative to the assessment of student learning (Wiliam 2006:283). According to Wiliam and Black (1996:537), Bloom, Madaus and Hastings (1971) defined summative evaluation tests as "those assessments given at the end of units, mid-term and at the end of a course, which are designed to judge the extent of students' learning of the material in a course, for the purpose of grading, certification, evaluation of progress or even for researching the effectiveness of a curriculum". Formative evaluation on the other hand, they referred to as "another type of evaluation which all who are involved – student, teacher, curriculum maker – would welcome because they find it so useful in helping them improve what they wish to do" (Bloom, Hastings & Madaus 1971 in Wiliam & Black 1996:537). In this context, the terms summative and formative refer to the functions of assessment and do not apply to the assessments themselves (Wiliam & Black 1996:538). As Bloom points out, the same test can be used for both summative and formative purposes (Wiliam 2006:284).

Australian educationalist, Royce Sadler, who has long been working in the field of formative assessment, distinguishes between formative and summative assessment based on purpose and effect and not on the actual timing (at what stage of learning) of the assessment. In order to serve a formative function, an assessment has to concern itself with "how judgments about the quality of student responses (performances, pieces, or works) can be used to shape and improve the student's competence by short-circuiting the randomness and inefficiency of trial-and-error learning" (Sadler 1989:120). Summative assessment, on the other hand, "is concerned with summing up or summarizing the achievement status of a student, and is geared towards reporting at the end of a course of study especially for purposes of certification" (Sadler 1989:120). Sadler further holds that summative assessment is essentially passive and, as opposed to formative assessment, does not have an immediate effect on future learning.

Maddalena Taras, generally supportive of his work, criticizes Sadler who presents summative assessment (SA) and formative assessment (FA) as distinctive entities (each with its own ideals and processes), arguing that "one inextricably leads to another" (Taras 2005:474). In her theoretical reflections of SA and FA, Taras notes that all assessments result in a summative judgement (in that the assessment documents all performances up to a given point). These summative judgements, however, can fulfil various functions (Taras 2005:468). What is done with the information from the assessment will determine whether the assessment remains summative or goes on to fulfil a formative role. Thus, where feedback from the SA is used to promote and modify learning, it constitutes a formative function and the assessment may be seen as formative.

The *function* or role of an assessment refers to the planned use or purpose of the judgement, such as a social or an educational function. Whereas the function of an assessment does not have an effect on the actual process of assessment, it will influence the choice of parameters such as criteria, goals and standards of the assessment (Taras 2009:59). The *process* of an assessment describes the actual activity of making a judgement according to predetermined criteria and standards (Taras 2009:58) – (*cf. page 65 for a further discussion of the process of assessment*).

In the Learning and Teaching Support Network Generic Centre's series of Assessment Guides and Briefings, Knight (2001:3) links the summative purpose of assessment to the summation of a person's achievement. He notes that summative assessment provides (what he terms) *feedout* in the form of information about performance and proof of achievement or competence (Knight 2001:3). Knight (2001:3) also points out the importance of objectivity, accuracy and reliability in terms of SA, referring to assessment for summative purposes as *high-stakes* assessment. This stands to reason as summative assessment is traditionally used in the validation and accreditation of students (Taras 2007:58).

Knight refers to FA in its simplest form by describing it as an approach to assessment, which is intended to inform students about how to do better. He feels that any task that generates feedback about a student's performance qualifies as formative assessment (Knight 2001:3).

This can be seen as an oversimplification of formative assessment. This becomes evident when considering Taras's description of formative assessment, which states that formative assessment identifies the gap between actual performance and the required standard, which it then communicates to the one being assessed via feedback. The feedback not only describes the gap, but also provides information on how to improve performance, which will enable the closure of the gap (Taras 2005:468).

Formative assessment can therefore be seen to comprise the following components or steps:

The first step in FA involves the collection and interpretation of information about performance (Wiliam & Black 1996:544). The responsibility for generating this information lies with the student in self-assessment or with another person, notably the teacher (Black & Wiliam 1998:20). The information gathered during the assessment should accurately reflect the difference between the actual and the desired levels of performance (Wiliam 2000:10). At this point the assessment can serve either a summative or formative function, or both. Knight (2001:10) points out that, whilst it is possible to set an assessment task for both formative and summative purposes, most experts in the field would advise against this. For others such as Taras, this is not a problem, as she firmly believes that SA constitutes the initial step of FA, and that consequently SA plus feedback plus the appropriate action to close the gap equals FA (Taras 2009:58).

The next step involves feedback. Ramaprasad's (1983:4-5) widely referenced definition of feedback holds that "feedback is information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way". Sadler (1989:120) regards feedback as central to formative assessment. From their review of more than 250 studies on FA, Black and Wiliam (1998) conclude that feedback contributes positively to learning and achievement across all levels of education, all knowledge and skills, and all content areas (Nicol & Macfarlane-Dick 2004:1).

For feedback to be effective, the student has to assume a central and active role in feedback. This, according to Nicol and Macfarlane-Dick (2004:2), requires the students to actively and continually monitor and regulate their own performance, not just in terms of their progress towards the goals, but also in terms of the strategies they employ to reach these goals. Nicol and Macfarlane-Dick (2004:2) refer to this as *internal feedback,* and explain that it is the product of self-assessment. Rushton (2005:511) emphasises the importance of self-assessment; he views self-assessment as a skill (which implies that it can be attained) integral to the process of learning, and contends that part of the formative assessment process should involve developing a student's self-assessment skill(s) (Rushton 2005:511) – a view shared by other writers such as Yorke (2003) and Boud (2000). Another source of feedback involves teachers, tutors, supervisors, peers, etc. – they provide *external feedback*. External feedback challenges students to reassess their knowledge and beliefs, which in turn may result in the modification of personal goals and tactics and strategies applied to reach the goals.

Assessment of students' performance, whether in reference to personal goals and standards, or goals and standards defined by the curriculum, will only be effective if the students have a notion of these goals and standards that they are expected to achieve and being judged against (Sadler 1989:121). To this end, Nicol and Macfarlane-Dick (2004:4) conceptualise feedback as a dialogue between students and the one providing feedback, as opposed to a mere unidirectional transmission of information. For feedback to instruct learning, students need to understand the feedback (as it is intended by the one providing the feedback) before assimilating the information into their own beliefs, goals and standards. This corresponds closely to the idea put forward by Wood (1987) in Yorke (2003:478) who contends that, for feedback to produce optimal results requires an active collaboration between the assessor/the individual providing the feedback and the one being assessed/the individual receiving the feedback. This resonates with Yorke (2003:481) who argues that simply informing students of the learning outcomes and standards they are expected to aim for does not "convey the richness of the meaning that is wrapped up" within these statements and requires further dialogue to enlighten the students.

Black and Wiliam (1998:36) make the point that the *quality* of the feedback is crucial to the success of formative assessment. Yorke (2003:482) agrees, asserting that the quality of feedback determines the effectiveness of formative assessment. External feedback that is not regarded as quality feedback includes untimely feedback, feedback not being relevant or informative, and feedback that is overwhelming in quantity. Nicol and Macfarlane-Dick (2004:6) identified the following as strategies to increase the quality of feedback:

- making sure that feedback is provided in relation to pre-defined criteria;
- providing feedback soon after a submission;
- providing corrective advice, not just information on strengths/weaknesses;
- limiting the amount of feedback so that it is used;
- prioritising areas for improvement;
- providing online tests so that feedback can be accessed anytime, anyplace and as many times as students wish; and
- focusing on students with the greatest difficulties.

The latter part of Ramaprasad's definition of feedback demands that action be taken for learning to take place. In accordance with this definition, Sadler (1989:121) avers that for students to improve their performance in response to feedback requires more than knowledge about their own performance and a concept of the standard or goal(s) being aimed for, the students also require the skill to find ways and means of producing the desired results (such as achieving the expected goals or bringing their performance in line with the expected standards). Therefore, in addition to being informative, feedback should also support (formative) the student in developing ways and means for reducing the discrepancy between performance and standard (Nicol & Macfarlane-Dick 2004:5). Feedback used correctly therefore develops students' active involvement in their own development, which is essential for lifelong learning.

It is also important for feedback to lead to action soon after it has been provided:

> *"The only way to tell if learning results from feedback is for students to make some kind of response to complete the feedback loop (Sadler 1989). This is one of the most often forgotten aspects of formative assessment. Unless students are able to use the feedback to produce improved work, through for example, re-doing the same assignment, neither they nor those giving the feedback will know that it has been effective"* (Boud 2000:158).

Sadler's (1989:121) influential concept of the three conditions necessary for academic improvement through the use of feedback, requires learners to have a general notion about the level of attainment and goals they are expected to achieve; compare their own performance with the expected level of performance – this action identifies and defines any shortcoming (usually referred to as the gap); and engage the necessary action in order to improve their performance (this should lead to a decrease in the gap).

Therefore, whilst Yorke (2003:477) holds that the basic idea of formative assessment seems simple enough, to contribute to students' learning by putting personal performances into perspective, it is evident that simply providing students with feedback, without expecting them to engage with the information, is unlikely to contribute significantly to any learning (Rust 2002 in Ahmed & Teviotdale 2008:2). This is also in line with the opinion of Sadler (1989:120) who states that "feedback can also be defined in terms of its effect rather than its informational content".

Although it has been 45 years since Scriven coined the terms summative and formative assessment, it has largely been the work of Black and Wiliam (1998), both independently and in collaboration, which has led to the widespread focus on formative assessment in compulsory and non-compulsory (higher) education. The publication of their seminal work in 1998 (Black & Wiliam 1998:7-74), a review of the literature of classroom formative assessment, proved to the world that formative assessment is an essential component of classroom work and that its development can contribute substantially to learning gains. In this article Black and Wiliam (1998:7) define formative assessment as "encompassing all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged", thus emphasising not only the importance of providing feedback, but also the importance of using the feedback to modify and improve learning. In a subsequent article, Inside the Black Box: Raising Standards Through Classroom Assessment, the same authors use the general term assessment

> *"to refer to all those activities undertaken by the teachers – and their students in assessing themselves – that provide information to be used as feedback to modify learning and activities. Such assessment* [they argue] *becomes formative assessment* [only] *when the evidence is actually used to adapt the teaching to meet student needs"* (Black & Wiliam 2010:82).

To the researcher, this definition demonstrates that all forms of assessment (both summative and formative) provide information; that this information describe the gap between the actual level of the work being assessed (reality) and the required standard (the ideal); that feedback can emanate from this information in both SA and FA; and that although feedback may include an indication of what the learner should do to improve the situation; only once the feedback is actually used to improve learning does the assessment activity have a formative function.

This is in line with Taras's notion that FA encompasses SA, for without the initial SA there will be no feedback and therefore no formative component to the assessment (Taras 2005:470-471). She further argues that the difference between SA and FA lies in the actual use of the information (by the learner) elicited by the assessment (Taras 2005:472). This naturally resonates with Taras's view that the same assessment can serve both summative and formative purposes, again differentiating between SA and

FA, not in terms of process or functions (social, political or educational choices which influence criteria and thereby product, but not the process), but the possible uses to which the product of the assessment may be put and how the assessment influences learning (Taras 2007:58).

Wiliam and Black's opinion (1996:544), reasoning that whereas all assessments have the potential to be summative, not all have the added ability of serving a formative function, does not appear to be in complete agreement with Taras's notion. Knight (2002:277) goes even further in suggesting that because of their different intentions, FA and SA instantiate different rules of engagement – they also have different rules of evidence.

Although Knight's definition of FA as "any task that creates feedback to students about their learning achievements" is unconvincing, his argument about different *rules of engagement* for SA and FA raises an interesting point (Knight 2001:3). SA provides information about an individual's level of performance and documents achievements – indicators that can be used in certification or promotion to higher levels of responsibility. Therefore, with SA the stakes are high and those being tested are likely to do all they can to conceal their shortcomings. With FA (where the intention is to create feedback and improve learning/performance) the stakes are generally not as high and learners need to be willing participants who are open about their limitations and uncertainties. Knight (2002:276) argues that those being assessed need to know the *rules of engagement*, for when the stakes are high, deception replace disclosure.

Higher education curricula contain increasingly more complex learning outcomes and soft skills claiming to cultivate qualities such as inter-personal skills, critical thinking, reflectiveness, and creativity. Knight (2001:7) asserts that where it is exceedingly difficult, if not impossible, to reliably assess these soft skills, formative assessment offers an invaluable alternative that not only provides information to the teacher, but also to the student in the form of feedback (which in turn contributes to student learning). A case in point, perhaps, where SA and FA are not as intimately linked as Taras would have it, and where the same assessment is unlikely to serve both summative and formative roles equally reliably.

Wiliam (2000:11) on the other hand, whilst acknowledging that formative and summative assessments do serve conflicting interests, does not believe that they are incompatible. To be able to serve both summative and formative functions, an assessment needs to be broad-based, and as far as possible, unpredictable (Wiliam 2000:11). He further advocates that the information (provided by the assessment) should be interpreted differently for summative and formative purposes. For summative purposes he recommends that the focus should be on synopsis, with the available evidence interpreted in such a way as to provide an optimal summary of the individual's performance and ability (Wiliam 2000:11). However, in order to meet formative requirements the focus needs to be on learning. Wiliam (2000:11) cautions that although the data provided by the assessment can serve either a summative or formative function, once it has been interpreted for the one, it becomes difficult to re-use the data for the other.

Perusing the literature on assessment, it is evident that there is a lack of an agreed-upon definition with regard to formative assessment – which seems rooted in some defining FA by its inherent characteristics as an assessment process, whereas others refer to FA in terms of its intended use as a classroom learning and teaching process (Dunn & Mulvenon 2009:20; Taras 2005:474); a difference of intent that, according to writers like Taras (2007; 2009), can be traced back to the earliest works of Scriven (1967) and Bloom (1971). The fact that FA can be used for a multitude of "feedback-related purposes such as diagnostic, prediction and evaluation of teacher and student performance" only complicates matters further, according to Dunn and Mulvenon (2009:2).

Notwithstanding the different views on formative assessment, educationalists and writers appear to be (even if only in principle) in agreement that FA can, when employed efficiently, make a significant contribution towards learning.

<u>Assessment procedure and issues of validity and reliability</u>

Taras (2005:467) refers to the process of assessment as the steps required to bring about a judgement. The following definition by Scriven (1967:40) describes the process of assessment and explains how the judgement is reached:

> *"Evaluation is itself a methodological activity which is essentially similar whether we are trying to evaluate coffee machines or teaching machines, plans for a house or plans for a curriculum. The activity consists simply in*

the gathering and combining of performance data with a weighted set of goal scales to yield either comparative or numerical ratings, and in the justification of (a) the data-gathering instruments, (b) the weightings and (c) the selection of goals" (Scriven 1967:40).

Taras (2012:3) deconstructs the process of assessment, as per Scriven's definition, as follows: Select the criteria against which the performance will be judged, generate and collect data about the performance, establish weightings to accommodate for a distorting factor and finally justify each of these. Defined as such, assessment comprises a single (albeit complex) process that should be neutral and capable of ethical justification.

Whereas we cannot (always) guarantee what assessment will be used for, we can control the process, including the parameters of the process (the outcomes, standards and criteria) that form the basis of the assessment. These parameters ensure that the assessment can be controlled, justified and explained. As mentioned earlier, although the intended use or purpose (functions) of assessment does not affect the actual process, it will influence the choice of goals, standards and criteria and, therefore, the product. Taras (2010:128) asserts that making the process of assessment, as well as the parameters and the products, explicit will contribute significantly to an ethical, fair and impartial assessment, acceptable to all concerned.

The traditional view of summative assessment is that of a mandatory, formal assessment administered at the end of a prescribed period of instruction. In this context the purpose of SA concerns validation, progression and certification; by that very fact the instrument has to be valid and reliable.

Validity refers to the accuracy of an assessment, that is to say whether or not it measures what it is supposed to measure. Messick (1990) provides us with a more formal definition:

"Validity is an integrated evaluative judgement of the degree to which empirical evidence and theoretical rationales support the adequacy and appropriateness of inferences and actions based on test scores or other modes of assessment" (Messick 1990:1).

Reliability, on the other hand, is concerned with the extent to which assessments are consistent. In other words, the outcome would be similar, were the assessment to be repeated (Harlen 2004:111).

The relationship between validity and reliability is generally expressed in a way that presents reliability as a precondition in determining the validity of an assessment – reliability is a necessary, yet insufficient, condition for validity according to Sadler (1989:122). Attempts to increase the reliability of an assessment by "gathering and using a restricted range of evidence" often have the negative effect of reducing the validity of the assessment (Harlen 2004:13). Conversely, extending the range of data collection in an attempt to increase the validity of the assessment may reduce the reliability of the assessment, especially if the assessment includes outcomes that are not easily gauged – such as higher-level thinking skills (Harlen 2004:13). Harlen (2004:13) concludes that in as much as summative assessment requires a compromise between validity and reliability, when it comes to formative assessment, validity is everything.

In support of his views, Harlen (2004:13) refers to Sadler (1989:122) who reasons that, in the context of formative assessment, validity is a sufficient but not necessary condition for reliability. Sadler contends that ensuring the validity of each judgement will contribute to the reliability of the assessment result (Harlen 2004:13). Harlen (2004:13) points out that in practice, what matters more, is the relationship between validity and reliability, and how they combine to produce dependability.

Stobart (2011:233) reasons that if validity is about the degree to which an assessment measures what it is supposed to measure, and the purpose of formative assessment is to stimulate further learning, then the validity of FA lies in how effectively further learning is supported.

Conclusions about the validity of an assessment (in this case FA) require knowledge about the purpose of the assessment, whether the assessment is fit-for-purpose and whether the assessment achieves that for which it was intended (its purpose). The validity (of an assessment) is also influenced by the manner in which the results from the assessment is interpreted and eventually used (Stobart 2011:233).

Stobart (2011:234) view these arguments – the validity of an assessment is measured against the intended purpose of the assessment, how well the interpretation and use of the results contribute to achieving the purpose for which the assessment was employed, and how effectively the assessment samples the domain it is meant to assess – as key elements in any discussion about assessment validity.

Whilst the first two arguments are implicit to the validity of formative assessment, Stobart holds that the third argument demands a need for clarity about what is being learned – also vital to the successful application of FA. Another key premise holds that reliability and fairness form part of validity; however, Stobart (2011:234), like Sadler (1989) before him, de-emphasises the role of reliability in FA and views reliability as a function of the quality of the information provided by the assessment and the quality of the consequent feedback.

The validity of formative assessment is implicit in how well it improves learning. While formative assessment has been proven to raise the standards of education (Black & Wiliam 2010:82), it is essential to realise that its mere implementation alone may not improve learning.

2.2.3.2 ***Workplace-Based Assessment***

The shift towards performance-orientated education, whether it is outcome(s)- or competence(y)-based, necessitated a change in the way we assess. The testing of theoretical knowledge alone is no longer an adequate predictor of how well an individual will perform in real life. With competence being defined in terms of any number of competencies, it stands to reason that an individual should have to acquire or master a varied set of competencies (as determined by the context within which the competence applies) in order to become competent. The challenge lies in providing proof of the attainment or mastery of the different predefined competencies. To further complicate matters Rethans, Norcini, Baron-Maldonado, Blackmore, Jolly, LaDuca, Lew, Page & Southgate (2002:90) argue that although there are many forms of assessment to demonstrate a doctor's knowledge or competence, there is evidence that competence does not reliably predict performance in clinical practice. To this end Miller (1990), as well as Wilkinson and Wade (2005) in Augustine, McCoubrie, Wilkinson and McKnight (2010:326), contend that the most authentic and realistic way to assess a doctor's competence is to appraise his/her performance whilst engaged in everyday practice.

In 2005, the PMETB (Postgraduate Medical Education and Training Board) released a paper on *Workplace-Based Assessment*. The authors contend that the traditional formal examinations that have been at the centre of postgraduate education over the past decades are inadequate when it comes to assessing clinical competence and the appropriate professional behaviour and attitudes. Evidence of clinical competence, professional behaviour and attitudes are seen in the workplace on a daily basis where it can be observed by educational supervisors, colleagues, patients and the public and so it is obvious that much of the evidence needed to make informed decisions about performance, can be collected in the workplace. Consequently the paper proposes an overarching assessment strategy that combines the assessment of knowledge and clinical skills with workplace-based assessment. This process, which spans the entire training period, should be mapped to a number of external standards and requirements as well as the curriculum, in other words, evidence of competence of performance has to be triangulated with multiple assessment tools that have been validated for the purpose (PMETB 2005:3).

Workplace-based assessment (WpBA) refers to "the assessment of day-to-day practices undertaken in the working environment" (PMETB 2005:6). Assessment in the workplace relies on the use of multiple assessment methods and assessors to provide different perspectives of the trainee in the workplace, as a means of effecting a complete (and hopefully accurate) judgement of an individual's performance in a real-world situation (Augustine *et al.* 2010:326).

Several characteristics make workplace-based assessment an attractive method for assessing a doctor's performance (adapted from Augustine *et al.* 2010:327):

Fairness – which depends on rigour (appropriate standard setting together with broad sampling across important topics), ensuring that all aspects of the syllabus are covered (using blueprinting to align the exam with the syllabus), and careful question construction and reuse of questions.

Charting of competence development – workplace-based assessment is an excellent potential source of information for evidence of progress and achievement that can be used to chart the development of competence – the accumulation of the data over a long period of time has the added advantage of increasing the validity of assessment.

Multiple perspectives – a complete assessment of an individual requires multiple perspectives of professional practice. Obtaining these multiple perspectives requires the utilisation of varied assessment methods and assessors. Not only does using multiple methods and assessors contribute significantly to the validity of workplace-based assessment, it also reduces unfair personal bias related to non-academic factors – this is in line with the premise that wide sampling (of an individual's performance) is crucial to the reliability (Hays, Davies, Beard, Caldon, Farmer, Finucane, Mcrorie, Newble, Shuwirth & Sibbald 2002 in PMETB 2005:8) and validity (Van der Vleuten, Newble, Case, Holsgrove, McCann, McRae & Saundres 1997 in PMETB 2005:8) of an assessment.

Total professional practice assessment – workplace-based assessment can provide qualitative, narrative and descriptive information that allows the assessment of non-interpretive skills such as the ability to work in a team, teach, reflect, do research and communicate.

Formative and summative assessment – workplace-based assessment provides information for educational supervision and feedback – summative data for formal assessment and formative data to be used for the personal and professional development of the trainee – with the proviso that feedback is provided timely.

Criticism and concerns levelled at workplace-based assessment include the cost of implementation, both financially and in terms of time (Finucane, Barron, Davies, Hadfield-Jones & Kaigaset 2002:959-964) – time needed to train assessors. Collecting data and analysing each trainee's performance require time and so does providing timeous and useful feedback to each trainee following each assessment – keeping in mind that WpBA involves multiple assessments and assessors in order to ensure reliability. Concern has been raised that organizing and undertaking assessments may distract trainers from providing actual training. Threats to the validity and reliability of workplace assessments exist in the form of patient mix and differences in case complexity (Norcini 2005:880-889). Additionally, it has been argued that trainees may alter their behaviour in assessed conditions, which may lead to the assessment measuring maximum competence as opposed to true performance (Wragg, Wade, Fuller, Cowan & Mills 2003:131-134).

The complex nature of competence requires a variety of appropriate assessment methods for looking at different aspects of performance. The usefulness of a specific assessment method varies for each specific assessment context and is dependent on a weighted combination of several criteria such as validity, reliability, acceptability, feasibility and the educational effect of the assessment on the trainee, as well as transparency, meaningfulness, cognitive complexity, directness and fairness (Van der Vleuten & Schuwirth 2005:309-310). The General Medical Council in the United Kingdom (GMC) prescribes that assessment methods should be chosen on the basis of validity, reliability, feasibility, cost effectiveness, opportunities for feedback and the impact on learning. Lindsell (2008:4) suggests that whereas summative assessment methods, such as multiple-choice questions (MCQs), are best used to test factual knowledge, workplace-based assessment tends to be used formatively for personal development and the development of professional competence.

The paper on Workplace Based Assessment (PMETB 2005) holds that the reliable assessment of medical competence necessitates the use of numerous and appropriate methods of assessment and should incorporate several different perspectives. The document subsequently outlines several key features in the design of a workplace-based assessment:

- The purpose of the assessment should be clear to all concerned.
- The content of the assessment needs to be made explicit and mapped against the curriculum.
- The assessment is formative and as such should elicit information that can be used to assist the candidate in his/her learning (to improve his/her performance).
- The assessment should provide sufficient evidence – both in terms of quality and quantity – to effect an informed and qualified judgement about the competence of the individual being assessed. This requires the use of a variety of assessment methods, several assessors, and broad-based sampling that covers all the relevant domains.
- The assessment should occur within the workplace.

- All aspects of the assessment should be quality assured – any measures used to establish and improve the reliability, validity, and feasibility should be stated unequivocally.

In the latest version of the GMCs *Standards for Curricula and Assessment Systems* – which prescribes the standards, and requirements that medical Royal Colleges, Faculties and specialty associations must apply when developing and monitoring curricula and assessment systems – the document stipulates the following requirements in terms of workplace-based assessment (GMC 2010:12): "assessments must be subject to reliability and validity measures; evidence must be collected and documented systematically; evidence must be judged against predetermined published criteria where available; the weight placed on different sources of evidence must be determined by the blueprint and the quality of the evidence; the synthesis of the evidence and the process of judging it must be made explicit".

In their article on Workplace-based Assessment in Radiology, Augustine *et al.* (2010:327) suggest that a suitable workplace-based assessment tool should build up a reliable profile using a minimal number of assessments; produce results which are consistent among assessors; have minimal impact on a busy workplace; be capable of being mapped to a comprehensive curriculum; assess a clearly defined activity accurately; produce easily documented results; be self-evident in use or at least easy to learn; be acceptable to both trainee and assessor; and provide clear standards of minimally acceptable performance. Examples of workplace-based assessment methods (being used in various medical specialities) include Mini-Clinical Evaluation Exercise (mini-CEX), Directly Observed Procedural Skills (DOPS), Case-Based Discussion (CBD), Multi-Source Feedback (MSF), Patient Survey (PS) and Teaching Observation (TO).

Multi-source feedback (MSF) focuses on the humanistic, non-cognitive aspects of professional performance (behaviours and attitudes) and is ideal for assessing qualities such as communication, leadership, teamwork, integrity, compassion, punctuality and reliability. Individuals (raters) working with the trainee are asked whether they have concerns about the candidate in several areas related to general behaviours and attitudes (for example showing respect for patients' opinions, privacy, dignity and confidentiality; giving appropriate and understandable information to patients; respecting other team members' roles; being readily available and accepting responsibility for his/her actions) – specialty-specific attitudes and behaviours can also be assessed in this way. Ensuring a reliable assessment of a trainee's behaviour requires responses from fifteen or more different raters – at least twelve according to a study performed by Wilkinson, Crossley, Wragg, Mills, Cowan and Wade (2008:364-373), entitled *Implementing workplace-based assessment across the medical specialties in the United Kingdom*. To improve validity and reliability the raters should come from different positions of association with the trainee (for example clinical colleagues, nursing and clerical staff) and have spent at least some time working with the trainee (Lindsell 2008:4).

According to Augustine *et al.* (2010:327) the direct observation of clinical practice is fundamental to the assessment of performance. The **Mini-Clinical Evaluation Exercise** (Mini-CEX) involves the direct observation of a trainee in a real-life clinical situation and is designed to assess the clinical skills that trainees use in real-life encounters such as history taking, examination and clinical reasoning. The trainee receives immediate feedback to aid learning. This method has been shown to have good reproducibility, validity and reliability in general medicine, but requires at least four assessments of any given area of performance (more if a trainee falls below standard) (Lindsell 2008:4). Using different assessors for the separate assessments further enhances validity and reliability.

Another form of clinical observation, **Directly Observed Procedural Skills** (DOPS), is designed to assess practical skills by evaluating the performance of a trainee in undertaking a practical procedure. Pre-determined components are evaluated and graded according to a structured checklist – these components include generic skills such as consent and communication, as well as the practical aspects of the procedure itself. Feedback is given immediately after completion of the procedure (the evaluation should not take more time than it takes to complete the procedure), so as to identify and discuss strengths and areas for development (Lindsell 2008:4). The validity and reliability of this method are dependent on sufficient encounters with a minimum number of trained assessors (Wilkinson *et al.* 2008:364-373).

The **Case-Based Discussion** (CBD) provides an indication of competence in areas such as clinical reasoning, decision-making and application of medical knowledge in relation to patient care. During the structured discussion of a selection of the trainee's cases, the trainee is questioned about the care provided in pre-defined areas such as problem definition (diagnosis), clinical thinking (interpretation of findings), management and anticipatory care (treatment and care plans) (Lindsell 2008:4).

Logbooks serve only to list functional activities and whilst the data do have a role in assuring that key procedures have been performed, this method contributes little to the assessment of a trainee's performance or competence.

The **Patient Satisfaction Questionnaires** (PSQs) follow a process similar to MSF, but relies on the opinions of patients as opposed to that of the trainee's colleagues. A typical patient survey requires a patient to rate his/her satisfaction with the service they received – they do this according to a rating scale (for example poor, fair, good, very good or excellent), or by agreeing with statements describing the care (for example "the doctor kept me waiting" – yes always, yes sometimes, no never, or hardly ever). Data accumulated from the single encounter questionnaires can assess a trainee's patient care competencies, interpersonal and communication skills, professional behaviour and aspects of systems-based practice. Patient satisfaction questionnaires or patient surveys have been shown to be a reliable method of assessment (Murphy, Bruce, Mercer & Eva 2009:219-232) but, as with many of the aforementioned, requires the opinions of around twelve to twenty patients to ensure reliability.

Teaching Observation (TO) is designed to assess trainees' competence at teaching, and to provide constructive formative feedback on their performance (JRCPTB 2014:Online). The assessment can be based on the direct observation of any formalised teaching led by the trainee (i.e. trainee-led).

Table 2.7 Workplace-based assessment methods used in various medical specialities (compiled from Lindsell 2008:3-5 and JRCPTB 2014:Online) [Table continues on next page].

Mini-Clinical Evaluation Exercise (Mini-CEX) • Mini-CEX evaluates a clinical encounter with a patient to provide an indication of competence in skills essential for good clinical care. • Trainees are observed by an assessor whilst undertaking tasks such as history taking, clinical examination and communicating with patients. • In order to ensure validity and reliability, the assessment should be repeated on a number of occasions in different clinical situations with different assessors. • The trainee receives immediate feedback to aid learning.

- It can be used at any time and in any setting when there is a trainee and patient interaction and an assessor is available.

Directly Observed Procedural Skills (DOPS)

- DOPS is designed to evaluate the performance of a trainee (against a structured checklist) in undertaking a practical procedure.
- It requires an assessor to observe a trainee whilst undertaking the procedure and then grading the performance of specific pre-determined components of the procedure.
- These components include generic skills such as consent and communication, as well as the practical aspects of the procedure itself.

The trainee receives immediate feedback to identify strengths and areas for development.

Case-Based Discussion (CBD)

- CBD assesses the performance of a trainee in his/her management of a patient to provide an indication of competence in areas such as clinical reasoning, decision-making and application of medical knowledge in relation to patient care.
- A selection of the trainee's cases is discussed in a standardised and structured oral assessment.
- A trained assessor questions the trainee about the care provided in pre-defined areas such as problem definition, clinical thinking, management and anticipatory care.
- It also serves as a method to document conversations about and presentations of cases by trainees.

Multi-Source Feedback (MSF)

- MSF permits an assessment of generic skills such as communication, leadership, teamwork, teaching, punctuality and reliability.
- It provides objective, systematic collection of evidence of and feedback about an individual's performance derived from a number of people working with the individual.
- Although the trainee will not see the individual responses by the raters, feedback is given to the trainee by the educational supervisor.
- To improve validity, the raters should be from a variety of different backgrounds, e.g. clinical colleagues, nurses, radiographers and clerical staff.

Patient Survey (PS)

- PS is intended to assess the trainee's performance in areas such as interpersonal skills, communication skills and professionalism by concentrating solely on his/her performance during one consultation.
- It addresses issues, including behaviour of the doctor and effectiveness of the consultation, which are important to patients.

Teaching Observation (TO)

- The TO is designed to provide structured, formative feedback to trainees on their competence in teaching.
- It can be based on any instance of formalised teaching by the trainee (the process should be trainee-led), which has been observed by the assessor.

Assessors can be any doctor with suitable experience – for trainees in higher specialty training this is likely to be consultants.

The application of WpBA in radiology

In the article, *Changes in postgraduate medical education and training in clinical radiology*, Lindsell (2008:4) poses the question ... "how much of this (referring to assessment in modern medical education and the varied assessment methods - *cf.* Table 2.7) applies to the specialty and what adaptations need to be undertaken to suit the uniqueness of the specialty?" – here the specialty being radiology. He argues that radiology is different from other specialities in many ways. Despite the general move away from the 'old model of learning through an apprenticeship relationship' in medical education, radiology trainees (especially in the early years) still work in a close apprenticeship relationship with senior personnel, which allows (mostly informal) assessment of their knowledge and skills in the workplace on a daily basis. This assessment, however, is usually not done in a standardised way and infrequently formally documented. Structured, standardised, reliable and valid assessment methods are therefore still needed to evaluate a trainee's work-based performance and competence formally.

Despite proven reliability, validity and feasibility, not all workplace-based assessment tools are appropriate for diagnostic radiology. Lindsell finds DOPS ideally suited to the assessment of interventional radiological procedures, as well as procedures inherent to diagnostic radiology, and predicts that adapted versions of mini-CEX and CBD should be equally suited to the task. Multi-Source Feedback and the assessment of auditing and teaching skills are non-specific measuring instruments that have a definite place in radiology, whilst MCQs likely are the most reliable and valid way of testing a candidate's knowledge base (Lindsell 2008:6).

The Royal College of Radiologists (RCR) in the UK piloted a number of workplace-based assessment tools during the period June 2008 to February 2009. Subsequently, the mini-IPX (an image interpretation tool based on a variation on the mini-CEX); Rad-DOPS (an adaptation of the DOPS); an audit assessment tool and a teaching observation tool have been introduced in all UK training programmes as from August 2010 (*cf.* Table 2.8) – supported by an ePortfolio which also went live at the same time (RCR 2012:160-162). The new RANZCR (The Royal Australian and New Zealand College of Radiologists) Radiodiagnosis Curriculum, introduced December 2009, also includes Radiology Direct Observation of Procedural Skills (Rad-DOPS), Mini Interpretation Patient Exercise (Mini-IPX), Critically Appraised Topics (CATs) and Multi-

Source Feedback (MSF) as structured in-training assessment tools in the formal radiodiagnosis assessment programme (RANZCR 2014:17-18).

Several articles, discussing the use of various WpBA tools in radiology, have been published over the past few years. A published report by Williamson, Steele, Gunderman, Wilkin, Tarver, Jackson and Kreipke (2002) found the OSCE appropriate for assessing the reporting skills of radiology registrars. The group initially set out to develop an Objective Structured Clinical Examination (OSCE) for assessing the reporting skills of radiology registrars and, following preliminary testing, found the OSCE suitable to the task at hand. In addition to its primary task, the authors also found the instrument capable of judging communication skills and the instructional strategies targeted toward these skills (Williamson *et al*. 2002:719-722).

In 2004, Wood, Collins, Burnside, Albanese, Propeck, Kelcz, Spilde and Schmaltz published an article on the use of 360-degree assessment in radiology. The 360-degree assessment tool is well suited to the assessment of professionalism and interpersonal/communication and the authors found the method valid and reliable in measuring these essential skills inherent to a competent radiologist (Wood *et al.* 2004:931-939).

Lockyer, Violato and Fidler (2008) set out to determine the feasibility of a multisource feedback programme for practising radiologists (using data provided by peers, referring physicians, co-workers and self). From their research the authors concluded that MSF is a practical way of comprehensively assessing the practice performance of radiologist (Lockyer *et al.* 2008:771-778).

Table 2.8 Diagnostic radiology workplace-based assessment methods developed by the Royal College of Radiologists in the UK (compiled from RCR 2012:160-162) [Table continues on next page].

Mini IPX • The Mini IPX is an image interpretation exercise. • The assessor observes the trainee interpreting an image study. • It can be conducted in a variety of settings across all modalities. • As with all workplace-based assessments, performance is measured using a rating scale. • An anchor statement in relation to the overall clinical judgement of the trainees informs the process and gives a framework for future development needs.

Rad-DOPS (the acronym for the direct observation of radiological procedural skills)

- The assessor observes the trainee undertaking a clinical practical radiological procedure in a variety of settings and modalities.
- Performance is measured using a rating scale, which reflects the patient-centred nature of this encounter.
- The assessment should take little more time than the procedure itself and is concluded by anchor statements that rate the trainee's overall clinical competence.

Multisource Feedback (MSF)

- Multisource feedback (MSF) is used to assess anonymously a trainee's behaviour, leadership, teamwork and communication skills across the domains of Good Medical Practice.
- The trainee, following a discussion with the educational supervisor, nominates his/her own raters; thus, feedback comes from the people with whom the doctor works.
- Strengths and areas for development can be identified from the feedback.

Audit Assessment

- The undertaking of an annual audit is a requirement for all trainees.
- The audit assessment is designed to establish the trainee's competence in completing an audit either through the written process or via a presentation.
- The rating scale rates the overall quality of the audit and informs the discussions on the trainee's development in this area.

Teaching Observation (TO)

- Radiologists have an increasing role in the teaching of a variety of healthcare groups, from undergraduates and foundation doctors to allied healthcare professionals.
- A trainee's teaching skills can be observed in a number of situations and settings, including multidisciplinary meetings, journal or research clubs.
- The assessment is designed to be flexible, wholly formative and developmental.
- The trainee receives instant feedback on his or her strengths and areas for development across a whole range of teaching issues.

2.2.3.3 ***Portfolios***

A portfolio, according to Redman (1994:11) in McMullan, Endacott, Gray, Jasper, Miller, Scholes and Webb (2003:288), "is simply a tangible record of what someone has done".

One of the earliest definitions of portfolios describes it as:

> *"a file or folder of information which has been accumulated about a student's past experiences and accomplishments … [it] can be the vehicle for organizing and distilling raw prior experiences in a manageable form for assessment … a process by which prior experiences can be translated into educational outcomes or competencies, documented and assessed for academic credit or recognition"* (Knapp 1975 in McMullan *et al.* 2003:288).

Seeing it as more than just a means of assessment and accreditation of prior learning, Brown (1995) proffers the following definition of a personal portfolio:

> *"A private collection of evidence, which demonstrates the continuing acquisition of skills, knowledge, attitudes, understanding and achievements. It is both retrospective and prospective, as well as reflecting the current stage of development and activity of the individual"* (Brown 1995 in McMullan *et al.* 2003:288).

The two definitions by Knapp (1975) and Brown (1995) denote a shift from the traditional view of portfolios (a collection of material that provides cumulative information about achievement and progress) to that of a learning portfolio which not only focuses on what has been achieved thus far, but also on the subject of learning. Reflecting on Brown's definition, in McMullan *et al.* (2003:288) suggest the following attributes of a portfolio:

- The owner of the portfolio decides the content.
- The content should be sampled from varied sources and reflect a diversity of information that provides a complete overview of the individual's performances.
- The content of the portfolio has the ability to convey the qualities, competencies and abilities of the individual – the retrospective component Brown referred to.
- A portfolio also acts as an indicator of potential development – the prospective element.

From their literature review on the use of portfolios and the assessment of competence, McMullan *et al.* (2003:283-294) submit their own definition of a portfolio.

> *"[A] collection of evidence, usually in written form, of both the products and processes of learning", which "attests to achievement and personal and professional development, by providing critical analysis of its contents"* (McMullan *et al.* 2003:288).

In their essay on *The use of portfolio learning in medical education*, Snadden and Thomas (1998:192) refer to the ways portfolios contribute to learning and personal development. Portfolios require the individual to provide evidence that learning has taken place, and it is via this process that portfolios encourage and assist the development of reflective and adult learning. Inherent in the process and by nature of their contents, portfolios are well suited to formative assessment and hence professional development. Central to the success of these processes are critical reflection and the role of the mentor (supervision).

In her discussion on the use of learning portfolios in radiology, Deitte (2008:664), when describing learning portfolios, refers to a set of key features implicit in learning portfolios.

- A portfolio represents a collection of evidence that attests to achievement and learning over a period of time.
- A portfolio requires the active involvement of the learner (learner-centred).
- A portfolio encourages critical thinking and self-reflection.
- A portfolio necessitates the active involvement of a mentor/supervisor.
- A portfolio can contribute to formative assessment.
- A portfolio may be used as a formal assessment tool.

From these key elements emerge at least two separate roles (of learning portfolios). Firstly, they have a formative purpose that encourages professional growth through the support of learning, teaching and professional development (Klenowski, Askew & Carnell 2006:267-286). This role requires involvement of both student (involved in self-reflection and critical thinking) and mentor/tutor/facilitator (in providing formative feedback and support). Klenowski *et al.* (2006:268) warn that the use of portfolios for formative and learning purposes depends on an understanding of key assessment concepts such as "the link between learning objectives and success criteria, the use of rich questioning and the role of feedback in a pedagogy focused on learning, self- and peer-assessment". In addition, students are required to be "open, trusting and prepared to be vulnerable, [and demonstrate a] willingness to explicitly expose their strengths and areas for development" (Klenowski *et al.* 2006:281). From the literature on portfolios, the following are some of the phrases/recurring themes that are used in relation to portfolios as a formative learning tool (compiled by the researcher): assuming ownership (of learning); promoting/encouraging responsibility and accountability towards own learning; taking charge of learning; a catalyst for growth (professional and personal); taking control of learning needs; developing self-reflection; promoting critical thinking; active involvement; and self-directed/reflective learning.

From these phrases we can conclude that in its formative role, portfolios embody an active and on-going process that engages the learner and focuses predominantly on the development of the individual (both professionally and personal) through the (self-directed) development of their learning.

As an instrument of learning, a portfolio approach relies heavily on experiential learning. In the words of Beard and Wilson (2013:26): "Experiential learning is the sense-making process of active engagement between the inner world and the outer world of the environment". There are of course numerous other definitions of experiential learning – a review of which falls outside the scope of this discourse – but the basic premise seems to be the interaction/interdependence between learning and experience. Boud, Cohen and Walker (1993:8) state that it makes no sense to view learning and experience as separate entities – experience is central to learning, ergo learning can only occur if the learners' experiences are engaged to some degree.

In contrast to the formative role, the second role involves the use of portfolios as formal (summative/quantitative) assessment tools (Carraccio & Englander 2004:383); in this case the emphasis is on the collection of evidence.

> *"The portfolio can provide a practitioner with evidence of: reflection on academic and clinical experiences, continuing professional development and lifelong learning, decisions about the quality of work, effective critical thinking skills, reflection on professional and personal growth, responsibility for learning and development of the skills necessary of a critical reflective practitioner"* (Klenowski 2002 & Pearce 2003 in McCready 2007:144).

McMullan *et al.* (2003:290) highlight several concerns implicated in the use of portfolios for summative assessment; issues such as confidentiality, validity, reliability and objectivity (the latter implicit in the need for standardisation of criteria where portfolios are used for SA). McMullan *et al*. (2003:291) recognise the conflict between summative assessment and the learning, developmental value of a portfolio. Where summative assessment is included as a purpose of the portfolio, it will in all probability influence the content of the portfolio – students are likely to censor the contents in favour of the assessment, omitting personal incidents (especially problem areas and difficulties). This reduced ownership will in turn impact negatively on the developmental use of the portfolio – the content omitted will usually disclose shortcomings, and it is so often these incidents that initiate real learning (Gerrish, McManus & Ashworth 1997 in McMullan *et al.* 2003:2009; Snadden & Thomas 1998 in McMullan *et al.* 2003:2009). Whilst agreeing with the argument about reduced ownership Harris, Dolan and Fairbairn (2001:284) also point out the opposite, which is that students may be reluctant to engage with portfolios if there is no pressure of assessment.

Considering the nature of the evidence in portfolios and the often subjective and qualitative nature of the assessors' judgements, authors such as Pitts, Coles, Thomas (1999) and Webb, Endacott, Gray, Jasper, McMullan and Scholes (2003) find the application of quantitative measures (reliability and validity) in portfolio assessment inappropriate and advocate the use of criteria such as credibility, transferability, dependability, confirmability, adequacy and appropriateness of data, verification with secondary informants, multiple raters and an audit trail as opposed to quantitative criteria such as validity and reliability. McMullan *et al.* (2003:291) suggest that the solution may lie in using formative assessment for the reflective part of the portfolio, with the remainder of the portfolio being assessed summatively (accounting for reliability and validity issues). Addressing the issues of reliability and validity, Carraccio and Englander (2004:384) similarly contend that a portfolio should strike a balance between creative/reflective components and structured components that can be evaluated; the underlying premise being that acceptable reliability and validity of the individual components (that can be evaluated) will translate into reliability and validity of the portfolio as a whole.

Portfolios encourage self-directed learning (Colbert, Ownby & Butler 2008:343), nurture a sense of responsibility for learning (Tochel, Haig, Hesketh, Cadzow, Beggs, Colthart & Peacock 2009:337) and show great potential as an assessment tool of competence (Carraccio & Englander 2004:386; Deitte 2008:669), especially in curricula with a strong focus on competencies (Van Tartwijk & Driessen 2009:799). The promise offered by portfolios, however, depends on many variables, including how well portfolio implementation is designed and sustained, the degree of high-level organisational support (Tochel *et al.* 2009:337), the commitment of the learners (in terms of maintaining portfolios and their capacity for self-assessment, self-reflection and self-directed learning), a mentor's level of investment in relation to the analysis of and discussion about the qualitative data presented in a portfolio (Van Tartwijk &

Driessen 2009:799), and the willingness to invest time and energy (by both student and mentor).

2.2.3.4 *The Progress Test*

There have been varied views on the role of knowledge in the development of medical expertise – more recent developments in cognitive psychology have continually shown that expert problem-solving requires expert knowledge, and that simply immersing oneself in practice does not lead to expertise (Dijksterhuis, Scheele, Schuwirth, Essed, Nijhuis & Braat 2009:464).

In the 2005 PMETB (Postgraduate Medical Education and Training Board) paper on Workplace-Based Assessment, the authors propose an overarching assessment strategy, which combines the formal assessment of knowledge and skills with workplace-based assessment. WpBA focuses on the day-to-day performance and assesses clinical competence and the appropriate professional behaviour and attitudes. Admittedly, many of these skills and attitudes assimilate some theoretical knowledge, but WpBA was not developed with the aim of testing theoretical knowledge.

Traditionally, modular tests or end-of-unit examinations and final examinations have been used to gauge the knowledge level of trainees. Modular tests or end-of-unit examinations have been found to have a major effect on learning – there are indications that they may lead to short-term exam-driven learning as students prepare themselves specifically for the tests (Newble & Jaeger 1983; Van Berkel, Nuy & Geerligs 1995). This form of testing was found to discourage individual learning pathways (a characteristic of postgraduate training), in that a student would rather study for the expected content of the test than to define and pursue their own learning objectives (Van Der Vleuten, Verwijnen & Wijnen 1996:104). In addition to this educational function, final examinations primarily serve a selective or accountability function which involves identifying any candidate who is unfit to practise (Van der Vleuten 2000:1217). Van der Vleuten (2000:1217-1219) argues that the narrow sampling inherent to all final examinations however erodes the reliability of this essential function. The inherent nature of final examinations require students to demonstrate only a limited scope of their knowledge, skills and attitudes, and when considering that competence is content specific, it becomes clear that this form of assessment offers only a snapshot of a candidate's performance that does not (reliably) allow any extrapolation to the maintained level of competence over time (Van der Vleuten 2000:1217).

Longitudinal knowledge testing, aimed at measuring growth of knowledge over time, offers an alternative approach to postgraduate knowledge assessment. Dijksterhuis *et al.* (2009:465) explain that longitudinal testing involves all learners, irrespective of the actual level or year of training. Each test samples the complete knowledge domain, with the level of knowledge tested equivalent to that expected at the end of the training period. The tests are repeated annually (or more frequently) throughout the entire training period. Although the process and spectrum of each test remain the same, the content differs. With the tests being too comprehensive to study for, it rewards all study behaviour that contributes relevant knowledge, and in the process encourages profound and deep learning.

According to Khoo, West, Wu and Kwok (2006:301) longitudinal testing employs the same (or equivalent) measurement instrument to test the same group of individuals on numerous occasions. Longitudinal testing collects information over a period of time, which according to the design of longitudinal study, is arranged chronologically in time (referred to as temporal ordering or arrangement). Khoo *et al.* (2006) elucidate that

> *"This temporal ordering of observations provides an enhanced ability to elucidate stability and change in individuals over time, to study time-related processes, and to establish the direction of hypothesized causal relationships"* (Khoo *et al.* 2006:301).

The progress test was designed by the School of Medicine, University of Missouri-Kansas City (UMKC) in collaboration with the then University of Limburg in Maastricht, Netherlands (presently Maastricht University) to assess the knowledge of undergraduate medical students. It was first launched in 1990 as the QPE (Quarterly Profile Examination) – described as a longitudinal examination of knowledge acquisition and retention (Arnold & Willoughby 1990:515).

Since then the progress test has established itself as a formative, longitudinal educational assessment tool for evaluating the development and sustainability of cognitive knowledge (i.e. thinking, reasoning and remembering) during a learning process, or, as Van der Vleuten *et al.* (1996:104) describe the progress test, "a comprehensive examination reflecting the (cognitive) end-objectives of the curriculum".

The progress test consists of approximately 250 (multiple) true/false questions. The test is comprehensive and representative of the complete domain of knowledge as held by the curricular learning outcomes. The test is administered at regular intervals during the year, at which time all trainees, regardless of their level, sit the test together. For each occasion a new test is prepared by randomly drawing questions from a large bank of objective multiple-choice or true/ false questions. The difficulty of the questions needs to reflect the level of knowledge expected at the end of the training period (graduation); the knowledge addressed should also be functional for the trainee upon graduation.

Questions may be answered with either true or false, or with a *do not know* option. A correct answer scores one mark while an incorrect answer is awarded a negative mark – the *do not know* option is neither penalised nor rewarded. The *do not know* option is included to improve the reliability of the test by discouraging guessing without incurring penalties (McHarg, Bradley, Chamberlain, Ricketts, Searle & McLachlan 2005:221-227). Forcing a student into guessing when he/she does not know the correct answer may either benefit (guessing correctly) or disadvantage (guessing incorrectly when incorrect answers are being marked negatively) his or her test scores. Either way, guessing reduces the reliability of the measurement, as the test score is not an accurate reflection of the student's knowledge. This is the problem faced by more junior students who, presented with graduate-level questions in the early years, have insufficient knowledge to answer most of the questions. Including a *do not know* option is also in line with the argument that a doctor should learn to recognise what he does not know, know when to ask for help, and not be forced to behave as if he knows everything (Muijtjens, Mameren, Hoogenboom, Evers & Van der Vleuten 1999:274).

In most multiple-choice tests the test score is calculated by adding the number of correct answers – this is referred to as the number-right scoring method. A correct answer does not always imply absolute knowledge of the fact and may result from the use of partial knowledge or from a lucky guess. In such an event the test score is not a true reflection of the candidate's (level of) knowledge. This has led to the introduction of scoring penalties for wrong answers. Here incorrect answers are penalised and test scores are expressed as the number of correct answers minus the number of incorrect answers – this is referred to as formula scoring. Frary (1988:33) explains that the formula score = the total number of correct answers – a fraction of the total number of incorrect answers, with the fraction dependent on the number of possible answers for each question. The scoring formula thus reads:

Score = R minus (W÷[n minus 1]) (where R is the number of right answers, W is the number of wrong answers and n the number of choices per question).

The scoring for true-false questions (where n=2) therefore boils down to correct answers minus incorrect answers (S = R minus (W÷[2 minus 1]). The principle behind this formula is that the number of correct answers accrued through guessing should be deducted from the total number of correct answers. This method of scoring has been criticised as being based on the unrealistic assumption that on each question the examinee either knows the correct answer or guesses randomly (Reid 1977:335).

In his comparison of formula scoring and number-right scoring, Lord (1975:7-11) suggested that, in terms of formula scoring, the examinees should refrain from answering a question only when they are convinced that their answer would be no better than a random guess.

> *"If there is a scoring penalty for wrong answers, on the other hand, and if the examinee wishes to maximize his expected score, then it is advantageous for him to answer each multiple-choice item whenever he has any valid partial information to guide him in choosing the right answer or in ruling out any of the alternative choices. If we wish him to know how to maximize his expected score, our test directions will inform him convincingly as to this strategy. Such directions will be referred to as formula-scoring directions"* (Lord 1975:8).

In their article, *The effect of a 'don't know' option on test scores: Number-right and formula scoring compared*, Muijtjens *et al.* (1999:267-275) make the following observations. Because of the *do not know* option (which carried no penalty) examinees tended not to guess whenever they felt unsure about the answer. This resulted in them forgoing the better than random chance of getting the answer correct, had they guessed (in effect discouraging guessing). The inclusion of a *do not* *know* option also made the examinees review their knowledge of a subject before answering the question – which has the added advantage of making them aware of gaps in their knowledge. Formula scoring increased the reliability of the test.

The use of negative marking with the inclusion of a *do not know* option therefore attempts to reduce the influence of random guessing on the final test score and thereby increases the reliability of the test (Muijtjens *et al.* 1999:267). Whereas this method discourages random guessing, it does encourage the examinee to think about the question and use any partial knowledge or whatever clues can be found to attempt to answer the question in an informed manner – mimicking real-life medical practice conditions. This approach may well deny the examinee of a few extra marks, but in return gives a more accurate reflection of the candidate's knowledge and his/her ability to use that knowledge.

In the article, *Assessment of Progress Tests*, McHarg *et al.* (2005:221-227), citing problems related to processing raw data produced by assessments, argue that there are several important decisions to make prior to undertaking the actual progress testing. These decisions include choosing "whether the test is norm-referenced or criterion-referenced; whether marking is negative or 'number-right'; whether the grades are reported on a continuous or a discontinuous scale, and whether the grades are weighted towards the most recent observations, or the entire set of grades is used to determine the final grade". The article reports that:

- In terms of *norm referencing versus criterion referencing*, McHarg *et al.* (2005:223-224) subscribe to a norm-referenced approach to grading, contending that norm-referencing is preferable where the potential for inter-test variability (such as with a progress test) is high.
- In terms of *negative marking versus number-right marking* they argue in favour of negative marking with the inclusion of an 'I do not know' option, due to the fact that it discourages guessing (which undermines the reliability of the test) and because most of the more junior candidates are unlikely to be in a position to answer many of the questions (McHarg *et al.* 2005:224-227).
- With regard to *aggregation and weighting*, the authors advocate a discontinuous scale for reporting of grades, weighting in favour of the most recent tests. McHarg *et al.* (2005:227-228) are of the opinion that, in terms of assessing competence, recent test results (as opposed to grades earned at the beginning of the course)

should carry more weight. The aggregation of results refers to the conversion of a set of progress test results, collected over a period of time, into grades that can be used in decisions about progression within the course. Important considerations include the ordinal nature of the data collected over a period of time and the "non-linear nature of student performance throughout the course" (McHarg *et al.* 2005:228).

There are several advantages to progress testing. It is believed that testing influences learning and modifies behaviour – in other words – students study what they believe will be asked in the tests or examination. Because progress tests cover the complete domain of knowledge considered a requirement for students on completion of the programme, it makes it impossible for students to revise for a particular test beforehand (progress testing minimises test-driven or test-directed studying). The progress test therefore compels the students to continuously acquire and assimilate information, which, according to McHarg *et al.* (2005:222), "breaks the link between learning and revision". Progress testing rewards all study behaviour that results in the acquisition of relevant knowledge and thus provides the freedom for individual learning pathways. Progress testing therefore has a positive influence on student learning and is believed to promote more profound and deep learning (Dijksterhuis *et al.* 2009:e465). Schuwirth and Van der Vleuten (2012:26) report that, under the influence of progress testing, not only do the amount of functional knowledge continues to grow over the years, but basic knowledge is retained as it is included in progress tests throughout the years of study. Furthermore, because the progress test is levelled at the knowledge expected of a graduate, students are from the outset familiarised with the level of knowledge expected of them at the conclusion of their studies.

Progress testing is formative and thus functions as a rich source of information for feedback, not only for the academic staff but also for the students themselves. One of the major advantages of progress testing, apart from identifying strengths and weaknesses in the knowledge of the student, is that it allows the student to continuously compare his or her level of knowledge or level of academic development against what needs to be achieved by the end of the curriculum (i.e. continuous self-assessment) (Van der Vleuten *et al.* 1996:105).

Progress testing focuses on functional knowledge. It discourages the short-term memorising of easily forgotten rote facts just for the sake of passing an examination, focusing, instead, on the development of deep-seated and functional knowledge (Semb & Ellis 1994 in Van der Vleuten *et al.* 1996:105).

Another advantage is curriculum independence – progress tests reflect educational end objectives and any change in the curriculum therefore has no direct consequences for organising the progress test (Schuwirth & Van der Vleuten 2012:28).

Progress tests offer better predictive validity as longitudinal data collection, and progress testing is more predictive of future competence/performance than any once-off measurement (Schuwirth & Van der Vleuten 2012:27).

Other advantages of progress testing include reliability of pass-fail decisions, reduction in examination stress, early detection of high achievers, and repeat examinations are no longer necessary (Schuwirth & Van der Vleuten 2012:26-27; Van der Vleuten *et al.* 1996:105).

Progress testing also has its disadvantages, such as poor predictive validity for achievement in the first year of study, inter-test difficulty variation, difficulty in identifying the core content to be tested and the resources needed for test development, administration, the upkeep of the question data bank and constant review of the process, *vis-à-vis* progress testing is labour intensive and costly (McHarg *et al*. 2005:2; Van der Vleuten *et al.* 1996:106).

2.3 CONCLUSION

An overview of the literature provided a theoretical grounding that informed the study; it also effected a theoretical framework in support of the empirical research component central to this study.

Chapter 2 provided a theoretical perspective on the following elements:

- the concept of competence (*cf.*2.2.1.1);
- outcomes-based and competency-based education (*cf.*2.2.1.2);

- curricular changes in international postgraduate radiology education, including the USA, UK, Australia and New Zealand (*cf.*2.2.2); and
- relevant concepts in educational assessment, including formative and summative assessment, workplace-based assessment, portfolios and the progress test (*cf.*2.2.3).

The next chapter, Chapter 3, entitled **Research Design and Methodology**, will provide an overview of the research design and methodology applied in this study.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

This chapter deals with the research design and research methodology of the study. First, the theoretical perspectives on the research design are provided. This is followed by a detailed explanation of the process of each technique, namely the literature overview, Delphi survey and semi-structured interviews. Methodology and design, sample selection and data analysis are also described.

Research, writes Denzin and Lincoln (2008:1), is scientific; it provides the foundation for reports about and representation of 'the other'.

Scientific research relies on the application of the scientific method. According to The Merriam-Webster Dictionary (2014b:Online) scientific method involves principles and procedures for the systematic pursuit of knowledge including the recognition and formulation of a problem, the collection of data through observation and experiment and the formulation and testing of hypotheses. The Oxford English Dictionary (2014b:Online) defines scientific method as a method of procedure that has characterized natural science since the 17th century, consisting of systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses.

> *"Scientific method refers to the body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge. It is based on gathering observable, empirical and measurable evidence subject to specific principles of reasoning"* (Isaac Newton (1687) in National Academy of Sciences 2009:111).

Scientific method evolved over time, with some of history's greatest and most influential minds adding to and refining the process. The Ancient Greek philosophers did not believe in empiricism and philosophers such as Plato believed that all knowledge could be obtained through pure reasoning. Aristotle was the first to realise the importance of empirical measurement, believing that knowledge could only be gained by building upon what is already known. Aristotle understood that abstract thought and reasoning had to be supported by real-world findings, through observation and measurement. Aristotle's methods involved studying what others have written about the topic, looking for general consensus about the subject and performing a systematic study of everything related to the topic (Shuttleworth 2009a:Online).

Although Aristotle may be viewed as the founder of empirical science, it was the Muslim scholars who, during the Golden Age of Islam, developed a scientific process resembling the modern method. They are credited with being the first to have used experiment and observation as the basis of science. Of all the Muslim scholars it is Ibn al-Haytham (965-1040) who is widely regarded as the architect of the scientific method. From here the methodology was refined by the enlightenment scientist-philosophers, such as Roger Bacon (1214-1284), Francis Bacon (1561-1626), Descartes (1596-1650), Isaac Newton (1642-1727) and a host of other great thinkers including Einstein, Russell, Popper and Feyerabend (Shuttleworth 2009b:Online).

3.1.1 Qualitative and Quantitative Inquiry

Whereas qualitative researchers use a naturalistic approach that seeks to understand phenomena in context-specific settings, quantitative research uses experimental methods and quantitative measures to test hypothetical generalisations (Hoepfl 1997:47). The emphasis of quantitative research is on facts and the measurement and analysis of causal relationships between variables (Golafshani 2003:597-598). The quantitative study of causal relations requires rigorous control of the conditions under which the study is performed – it also requires a study design that effectively excludes the influence of the researcher and any other individual involved in the study (Flick 2009:13). The researcher's methods involve the "use of standardised measures so that the varying perspectives and experiences of people can fit into a limited number of predetermined response categories to which numbers are assigned" (Patton 2001:14). Data collected during the research is presented in the form of numbers that can be quantified and summarized, the mathematical process is the norm for analysing the numeric data and the final result is expressed in statistical terminologies (Charles 1995 in Golafshani 2003:598). The aim of such a meticulous research design is the generalization of findings and the formulation of general laws (Flick 2009:13).

Denzin and Lincoln (2008) highlight this deliberate disregard for rich descriptions (as this interferes with the process of generalisation) by the quantitative researcher as one of the main differences between qualitative and quantitative inquiry. Some of the other differences are the capturing of an individual's point of view, the examination of the constraints of everyday life and the acceptance of postmodern sensibilities by qualitative researchers (Denzin & Lincoln 2008:15-16).

Denzin and Lincoln (2008:14) conceptualise qualitative inquiry as follow:

> *"The word qualitative implies an emphasis on the qualities of entities and on processes and meanings that are not experimentally examined or measured (if measured at all) in terms of quantity, amount, intensity or frequency. Qualitative researchers stress the socially constructed nature of reality, the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry"* (Denzin & Lincoln 2008:14).

Flick (2009:14) identifies the following as the key features of qualitative research: the various theoretical approaches and their methods that characterise qualitative inquiry, the selection and application of the appropriate research method, the recognition and analysis of the variety of perspectives held by the participants of the study, and the contribution – to the process of knowledge production – of a researchers' reflection on their research.

Strauss and Corbin (1990) in Golafshani (2003:600) define qualitative research simply as "any kind of research that produces findings not arrived at by means of statistical procedures or any other means of quantification". Qualitative methods facilitate the in-depth and detailed study of issues without being constrained by predetermined categories of analysis; this contributes to the detail, depth and openness of the data collected during the qualitative inquiry (Patton 2001:14). Denzin and Lincoln (2008:3) affirm that "qualitative research is a field of inquiry in its own right". It relies on an interpretive and naturalistic approach to the world, studying things in their natural setting. This affords the researcher the opportunity to study the phenomena in terms of the meanings people bring to them (Denzin & Lincoln 2008:4). Naturalistic inquiry involves the collection of a variety of empirical data through specific methods of data collection including in-depth qualitative interviews, participant and non-participant observation, focus groups and document analyses. The collected data are then subjected to a "wide range of interconnected interpretive practices, hoping always to get a better understanding of the subject matter at hand" (Denzin & Lincoln 2008:4-5). The acceptance or validity of this 'understanding', in turn, will depend on the evidence in favour of or against the theory or hypothesis.

Unlike quantitative research where investigators tend to dissociate themselves as much as possible from the research (Winter 2000:Online), qualitative researchers tend to immerse themselves in the data collection processes. They involve themselves in the study without attempting to manipulate the phenomenon of interest or place prior constraints on what the outcomes of the research will be, allowing real-world situations to unfold naturally (Patton 2001:39).

It has become commonplace to classify all non-quantitative research as qualitative (Rolfe 2006:306). Holloway and Wheeler (1996) in Rolfe (2006:306-307) and Munhall (2001) in Rolfe (2006:306-307) contend that, despite the variety of designs and methods subsumed under the heading of qualitative, all these methods have a number of features in common. These features characterise qualitative enquiry and contrast with the beliefs and traditions of quantitative methodologies. According to these features, qualitative research focuses on the human experience, observes and interact with people in their natural setting and produces data of a descriptive or narrative nature – the approach to research is described as holistic and researchers are intimately involved in the process of producing data (Munhall (2001) in Rolfe 2006:306). It has been argued, however, that even this is an oversimplification of the distinction between qualitative and quantitative traditions and that not all qualitative methodologies comply with the above-mentioned criteria (Rolfe 2006:307).

On the surface it is therefore easy to oversimplify the distinction between the positivist-quantitative paradigm and interpretivist-qualitative way of doing research. However, although positivists and antipositivists/interpretists stand in opposition (at least in definition), their equated research methodologies and, perhaps more specifically, how the research is judged and what is accepted as scientific proof have led to considerable debate amongst advocates of both paradigms. There are, however, some commonalities between quantitative and qualitative research, and authors like Niglas (2007:3) are of the conviction that the "practice of educational research benefits from both broad methodological approaches and can be enhanced if qualitative and quantitative methods will be taken as complementary ways of studying educational phenomena and not as mutually exclusive paradigms". The same writer puts qualitative and quantitative research designs at the opposite ends of a continuum, preferring to "look at methodology as a qualitative-quantitative continuum" (Niglas 2007:4). In the preface of their book *Qualitative-Quantitative Research Methodology,* Newman and Benz (1998) also reject the dichotomy assumed by the debate that would have either qualitative or quantitative research technique eventually emerge as superior and take the position "that the two philosophies are neither mutually exclusive (i.e. one need not totally commit to either one or the other) nor interchangeable (i.e. one cannot merge methodologies with no concern for underlying assumptions). Rather, we present them as interactive places on a methodological and philosophical continuum based on the philosophy of science" (Newman & Benz 1998:xi).

This study employed both quantitative and qualitative design elements. The Delphi method proved ideal for engaging expert opinion and views on the design of a curriculum for postgraduate radiology training, whilst the more qualitative semi-structured interviews facilitated the discussion of the proposed continuous assessment programme, which in turn afforded the researcher the opportunity to obtain rich information, including views, opinions and new ideas about continuous assessment in postgraduate radiology and which eventually contributed significantly to the final version of the continuous assessment programme.

3.1.2 Sample Selection

The methods used during sample selection can best be described as a combination of different forms of purposive sampling, namely intensity sampling and criterion sampling.

Cohen and Crabtree (2006:1) define *intensity sampling* as the process of selecting or searching for rich or excellent examples of the phenomenon of interest. Intensity sampling allows the researcher to select a small number of rich cases that provide in-depth information and knowledge of the phenomenon of interest. Patton (2001:38) points out that "this form of sampling requires prior information and exploratory work to be able to identify examples".

According to Patton (2001:238), *criterion sampling* involves selecting cases that meet some predeterminded criterion of importance. Criterion sampling "can be useful for identifying and understanding cases that are information rich and provide an important qualitative component to quantitative data" (Cohen & Crabtree 2006:1).

The above forms of purposive sampling, namely intensity and criterion sampling, were utilised in both the Delphi survey and semi-structured interviews.

3.2 RESEARCH METHODS

In this section, the research methods that were used – the literature overview, Delphi questionnaire survey and semi-structured interviews – and which formed the basis of the study, will be discussed in detail. Information regarding the sampling, data collection, data analysis, ethical considerations and validity and reliability aspects of the study will be included.

3.2.1 Literature Overview

A literature overview affords the researcher informed insight into the problem he/she aims to study or research. An overview of the literature has as its aim the contextualising of a problem against related theory and research, as well as to ensure that the researcher is sufficiently knowledgeable about the topic to be able to investigate the topic in an informed manner (Singleton & Straits 1999:544). Bowen (2005:210) recommends that the researcher should read extensively as this ensures an overview of the existing literature and approaches to a particular topic, which in turn helps the researcher determine gaps and areas where further research is needed.

Fouché and Delport in De Vos, Strydom, Fouché and Delport (2012:134-135) explain the necessity of an in-depth literature review with reference to the following salient points:

- It reduces the chance of selecting an irrelevant or out-dated topic/focus by exploring what has already been done in a particular problem area;
- it grants the researcher opportunity to ensure that nobody else has already performed what is essentially the same research;

- in discovering research related to the intended topic/focus of study, the researcher may benefit from the efforts of others in terms of the identification of procedures, techniques and designs worth copying or pitfalls to avoid;
- it affords the researcher the opportunity to learn more about the history, origin and scope of the research problem;
- it allows the identification of leaders in the specific field of study;
- a good literature review places the project in context as it reveals the path of prior research and how the current project is linked to the former;
- it explains the differences between the findings (based on data collected) and existing knowledge, where it supports existing knowledge and how it may advance knowledge.

An Internet search formed the backbone of the literature overview. An initial Internet search using key phrases such as postgraduate radiology education, postgraduate radiology training, postgraduate radiology curriculum, workplace-based assessment (methods) identified numerous key concepts such as CanMeds, progress test, portfolios, direct observation of procedural skills, multi-source feedback, mini-imaging interpretation exercise, case-based discussion, critically appraised topics, patient survey and teaching observations. Another Internet search using key phrases such as modern educational concepts and Educational Concepts in Medicine identified numerous key concepts such formative and summative assessments, competence and competence(y)-based education, outcomes and outcomes-based education. These secondarily identified key concepts were then researched (using mostly the Internet). Identified key articles were evaluated and references scanned in order to identify related and useful articles. Helpful information was referenced and acknowledged as such.

For this study, the literature overview was used to acquire scientific information about:

- postgraduate radiology education in South Africa;
- postgraduate radiology education in the rest of the world;
- changes in radiology education at a postgraduate level over the past 10-15 years;
- changes that have been made to curricula for postgraduate radiology training by various international radiology colleges such as The American Board of Radiology (ABR), The Royal Australian and New Zealand College of Radiologists (RANZCR) and The Royal College of Radiologists (RCR);

- the use of Workplace-Based Assessment Methods in medical education and specifically postgraduate radiology education:
    - Radiology Directly Observed Procedural Skills (Rad-DOPS)
    - Multi-Source Feedback (MSF)
    - Mini-Imaging Interpretation Exercise (Mini-IPX)
    - Mini Clinical Evaluation Exercise (Mini-CEX)
    - Case-Based Discussion (CBD)
    - Critically Appraised Topics (CAT)
    - Patient Survey (PS)
    - Teaching Observation (TO),
- the use of portfolios in postgraduate radiology education;
- the use of Multiple Choice Questions (MCQs) as assessment tool in postgraduate radiology education;
- the Progress Test and its use in postgraduate radiology education; and
- the CanMEDS principles and how these have influenced curricula for postgraduate radiology training worldwide.

The overview of the literature facilitated the contextualisation and conceptualisation of postgraduate radiology education. The literature overview gave perspective on the changes in postgraduate radiology education over the past 10-15 years – including the changes to international postgraduate radiology curricula and the assessment methods and frameworks utilised in modern day curricula. This knowledge informed suggestions about changes to the postgraduate radiology curriculum currently employed by the UFS – predominantly in terms of modern educational concepts and non-radiological content as most of the changes to radiology-specific content were facilitated by the data accumulated during the Delphi survey. The overview also provided information about the various assessment methods available to, and being used in, postgraduate medical education (including radiology). This knowledge later formed the scientific basis for the development of the outcomes-based continued assessment programme, whilst the literature overview also aided in defining outcomes around which the assessment programme could be structured. (*Cf.* Chapter 2 for a full discussion on the literature underpinning this study.)

Importantly, the literature overview never intended to be a complete and systematic, critical and analytical review of all the available literature pertaining to postgraduate radiology education.

3.2.2 The Delphi Questionnaire Survey

3.2.2.1 *Theoretical Aspects*

The Delphi Method started life as "Project Delphi", the name given to a US military-sponsored research study developed in the 1950s by the RAND Corporation's Norman Dalkey, Olaf Helmer and Nicholas Rescher. The study had as its objective the development of a systematic, interactive forecasting method, which relies on (the consensus of) a panel of experts, based on the assumption that group judgments are more valid than individual judgments (Dalkey & Helmer 1963:458-467; Linstone & Turoff 2002:3).

It is widely held that the Delphi method takes its name from of the legend of the Greek Delphic oracle (Kennedy 2004:505). The story of the founding of the Delphic oracle is told in the Pythian part of the Homeric hymn to Apollo (Chappell 2006:331); an ancient Greek hymn, dedicated to the god Apollo, thought to date back to the second half of the seventh century or the early sixth century BC (Chappell 2006:335). The hymn explains how Apollo travelled all over Greece until he came to Delphi, home to the most important oracle (priestess) throughout the classical Greek world, situated on the south-western face of Mount Parnassus. According to Greek mythology, Apollo proclaimed himself master of Delphi after slaying the dragon, Pathos, who protected the site. According to legend, Apollo's prophesies of the future were transmitted thorough female intermediaries known as Pythia (Keeney, Hasson & McKenna 2011:2). The Pythia or priestess of the Temple of Apollo at Delphi – also commonly known as the *Oracle of Delphi* – was widely credited for her prophesies inspired by Apollo and, according to Kennedy (2004:505), "was considered to be one of the most truthful", relying on a network of informants and data gleaned from varied sources.

Today the Delphi technique is a widely used and accepted method for achieving convergence of opinion concerning real-world knowledge, solicited from experts within certain topic areas (Hsu & Sandford 2007:1).

Kennedy (2004:505) views the modern Delphi method as a "constructive effort in building knowledge by all who share in the process", whilst McKenna (1994:1222) sees the main advantage of the Delphi method as "the achievement of concurrence in a given area where none previously existed".

> *"It provides an opportunity for experts (panellists) to communicate their opinions and knowledge anonymously about a complex problem, to see how their evaluation of the issue aligns with others, and to change their opinion, if desired, after reconsideration of the findings of the group's work. The work continues over a series of iterative rounds until consensus or stability is reached about the problem at hand"* (Keeney, Hasson & McKenna 2001 in Kennedy 2004:505).

In the introduction of the book *The Delphi Method: Techniques and Applications*, Linstone and Turoff (2002:3) submit that "Delphi may be characterised as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem". Although the authors are unwilling to commit to a "detailed and explicit definition" of the Delphi technique, suggesting that "in its design and use Delphi is more of an art than a science", they do, however, assign certain core principles to the structure of this investigative communication process which allows for individual contributions of information and knowledge, the assessment of these individual contributions and subsequent formulation of a group judgement or view, the opportunity for individuals to revise their opinions and responses and anonymity of the individual responses (Linstone & Turoff 2002:3). Rowe and Wright (1999:354) provide a similar perspective in their characterisation of the classical Delphi:

- Anonymity of the Delphi participants allows group members free expression of their opinions without undue social pressures to conform to others in the group.
- Iteration allows participants the opportunity to refine their views in light of the progress of the group's work.
- Controlled feedback informs the participants of the other members' perspectives and provides the opportunity for participants to clarify or change their views.
- Statistical aggregation of group responses allows for a quantitative analysis and interpretation of data.

Delphi usually undergoes four distinct phases (summarised and tabulated from Linstone & Turoff 2002:5-6):

1) Exploration of the subject under discussion, with each individual contributing additional information he/she feels is pertinent to the issue.

2) Understanding how the group views the issue; that is, where the members agree or disagree, and what they mean by relative terms such as importance, desirability or feasibility.
3) In the event of a significant disagreement, that disagreement should be explored in an attempt to identify the underlying reasons for the differences; allowance is made for further evaluation of these underlying reasons.
4) A final evaluation occurs when all previously gathered information has been initially analysed and the evaluations have been fed back for consideration.

Although Delphi may seem an uncomplicated and easy-to-implement research tool, the success of the Delphi depends on: how well the monitor avoids imposing his/her view and preconceptions of the problem on the respondent group (by not over-specifying the structure of the Delphi and not allowing for the contribution of other perspectives related to the problem), how well the group responses are summarised and presented to the group, not ignoring but exploring disagreements (so that respondents do not become discouraged and drop out, which may lead to an artificial consensus being generated), and not underestimating the demanding nature of a Delphi (respondents should he recognized as consultants and properly compensated for their time if the Delphi is not an integral part of their job function).

Despite the literary debate around the value of using so-called 'experts' (or at least informed advocates), as opposed to panellists who are merely representative of the target population, most Delphi studies recruit individuals who are viewed as experts on the particular issue or topic under study (Goodman 1987:730-732).

Choosing a good respondent group (panel of experts) is central to Delphi achieving its goal and investigating what it sets out to investigate (Linstone & Turoff 2002:6) – in other words, the selection process and choice of individuals for the Delphi panel has a direct influence on the validity of the study. There are several difficulties associated with choosing a panel of experts, including the sampling procedure adopted in selecting panel members and determining a panel's level of expertise. The definition and concept of the term *expert* – although widely accepted and used – have also led to widespread debate in the literature. Adler and Ziglio (1996) in Keeney *et al.* (2011:24) add to this debate by outlining four requirements for expertise: knowledge of and experience with the issues under investigation; the capacity and willingness to participate; sufficient time to participate in the Delphi and effective communication skills.

This gave rise to the arguments that knowledge may not necessarily be consistent with expertise and that experience does not make an individual an expert as he/she may lack the knowledge or skills expected of an expert. In an attempt to ensure the suitability of the panellists, candidates could be asked to rate themselves in terms of their expertise in and knowledge about the topic. Another approach relies on the selection of experts on the basis of specified criteria (using a selection matrix consisting of predetermined criteria) that value the contribution of either the knowledge expert or informed individual.

Finally, the use of well-constructed questionnaires carefully piloted and reviewed by experts in the area of research will add to the reliability of the study.

3.2.2.2 *The Delphi Process and Questionnaire in this Study*

Prior to commencement of the research, permission and consent had to be obtained from the participants. A letter of invitation to participate in the Delphi questionnaire survey (*cf.* Appendix A1) was sent to the selected respondents (*cf.* 3.2.2.5), followed by a consent form (*cf.* Appendix A2), which had to be completed by all respondents who agreed to participate.

The Delphi questionnaire was chosen as a quick and cost-effective method of gathering expert opinions. The format of the process allowed experts to consider their responses in their own time without the outside influence of the other respondents. Allowing for comments from the respondents further enriched the research process and aided in eliminating researcher bias in terms of the construction of the Delphi questions.

The aim of the Delphi questionnaire was to gauge and unify the opinions and views of the chosen panel of experts about the curricular content of postgraduate radiology training – specifically at the UFS but also in a broader sense, in terms of the South African context. This information was instrumental in defining the characteristics required of a diagnostic radiology graduate in South Africa.

The content of the Delphi questionnaire was based on the content of the RANZCR Radiodiagnosis Training Program Curriculum, the RCR Specialty Training Curriculum for Clinical Radiology and the ABR Diagnostic Radiology: Core Examination Study Guide. As a radiologist with a postgraduate diploma in general interventional radiology and working in an academic radiology department with a very active interventional radiology component, the researcher was particularly interested in the breadth and depth of interventional radiology procedures that should be included in the training of a general radiologist in South Africa. This led to the inclusion of a wide spectrum of interventional radiology procedures in the questionnaire.

The questionnaire consisted of two main sections: the first section addressed the curriculum in terms of expected outcomes for a diagnostic radiology graduate, whilst the second focused on the continuous assessment of a registrar during the training programme.

The responses for Section One were limited to three options, encouraging the respondents to make a definitive decision about each question. Section Two, dealing with what should be assessed and at which stage of the students' training various assessments should take place, initially gave the respondent a choice of four options. However, delays in obtaining consensus prompted a reduction in the options from four to three by integrating the first of the four choices into one – this was done after round two and in accordance with the promoters' views.

A description of the questionnaire as measuring instrument will be presented in Chapter 4, followed by a discussion of the different Delphi rounds.

3.2.2.3 *Target Population*

Most of the world's knowledge is based on sampling (De Vos *et al.* 2012:223); sampling identifies a smaller group of individuals (from a population) *considered* to be representative of that total population. A population, according to De Vos *et al.* (2012:223), refers to a group of individuals who possess similar specific characteristics – also referred to as the sampling frame by McBurney (2001) in De Vos *et al.* (2012:223).

A target population can therefore be seen to consist of a well-defined group of individuals, known to have similar characteristics, with whom the research problem is concerned. Considered representative of the population from which they were selected therefore allows the researcher to generalise the conclusions of the study to the rest of the population.

For the Delphi survey the target population consisted of a panel of experts chosen from individuals (both national and international) involved in postgraduate radiology education – the selection process favoured individuals affiliated with the seven South African academic radiology training units, although radiologists in private practice were also included as they brought with them knowledge of what is expected of a radiologist involved in private practice.

3.2.2.4 *Survey Population*

Whilst a target population (also known as the scope of the survey) is the population about which information is to be sought, a survey population (also known as the coverage of the survey) is the population from which information can be obtained in the survey (UN 1999:14).

With regard to the Delphi, the survey population represented the group of respondents that agreed to participate in the Delphi questionnaire survey and had completed, signed and returned the consent forms – in this case, that represented a total of 11 candidates (one international radiologist, three radiologists in private practice in South Africa and seven radiologists in full-time academic practice, affiliated with universities in South Africa). One candidate unfortunately never engaged the Delphi process whilst a second withdrew after Round One of the Delphi survey, leaving the international candidate, three private and five academic radiologists to complete the survey.

3.2.2.5 *Sample Size*

The number of candidates qualifying for the Delphi survey totalled 15 and consisted of one international radiologist (previously head of the academic radiology department at a South African university), five radiologists involved in full-time private practice and employed by radiology practices around the country and nine consultant radiologists affiliated with South African universities on a full-time basis.

3.2.2.6 *Description of the Sample*

In choosing the respondent group (Delphi expert panel), a selection matrix allowed the comparison of candidates to one another, based on criteria chosen in consultation with the promoters. These criteria defined the attributes of the experts that eventually comprised the Delphi panel and included:

- Radiology qualification/ Qualified radiologist.
- Minimum five years' postgraduate study.
- Actively practising as a radiologist.
- Private or academic practice.
- Involved in radiology curriculum/ academic programme planning.
- Involved in radiology teaching.
- Radiology examiner or involved in radiology assessment.
- Examiner in radiology finals.
- Published or presented on radiology education.
- Published on radiology, nationally or internationally.
- Presented at international radiology congresses or workshops.
- Involved with the RSSA or College of Radiology (of South Africa).

The Delphi panel eventually comprised of qualified radiologists in full-time private practice (in various provinces throughout South Africa), qualified radiologists affiliated with the academic radiology departments of four different South African Universities and employed by the relevant provincial health departments, as well as a qualified radiologist working internationally. All participants are qualified radiologists with at least five years post-graduate experience and presently still actively practising radiology. All (except for the private radiologists) are directly or indirectly involved in radiology curriculum and or academic programme planning and all have at some stage been involved in assessment or have acted as an examiner in final radiology examinations (the majority are presently still involved). An Internet search found radiology-related publications by all but one of the academic radiologists; however, very few of these articles were on radiology education. Evidence of presentations at international radiology congresses or workshops was found for only two of the candidates. As private radiology is the largest collective employer of graduate radiologists, their input is essential and adds a valuable broader (marketplace-related) perspective to the expected qualities of a graduate radiologist.

Criteria for the exclusion of eligible candidates from the Delphi process were stipulated as:

- lack of availability;
- not giving consent to participate; and
- being a possible examiner of the PhD thesis.

3.2.2.7 *Pilot Study*

A pilot study as defined by Barker (2003:327-328) in De Vos *et al.* (2012:237), refers to the testing and validating of a measuring instrument by administering it to a small number of individuals from the target population – with the caveat that those participating in the pilot study should not participate in the main study (Rubin & Babbie 2005:219). Bless, Higson-Smith and Kagee (2006:184) in De Vos *et al.* (2012:237) refer to a pilot study as "a small study conducted prior to a larger piece of research to determine whether the methodology, sampling, instruments and analysis are adequate and appropriate". Mouton (2001:103) views piloting as an important component of research, suggesting that one of the most common errors in doing research is omitting pretesting or piloting.

The pilot study ideally should be executed in a manner similar to that planned for the main investigation, that is, if the researcher plans to mail the questionnaire in the main study, then this should be done during the pilot study (De Vos *et al.* 2012:241). It is pertinent to provide space for comments or criticisms the respondents may have. Any comments and criticisms, together with the data collected from the pilot study, should be processed and evaluated by the researcher. This step should include the processing, interpretation and analysis of data collected, in an effort to ensure that the intended statistical analysis can be done or the intended qualitative themes can be identified. The pilot study gives the researcher a final opportunity to make necessary modifications in time for the main investigation. The researcher however, should guard against statements and generalisations based exclusively on the findings of the pilot study (De Vos *et al.* 2012:246).

A pilot study was conducted with the goal of testing and adjusting the Delphi questionnaire – to improve comprehension – and to solve any procedural problems. The questionnaire was first reviewed by the promoter and one of the co-promoters, where after two selected individuals (one a qualified radiologist and head of an academic radiology department, and the other a qualified radiologist employed by a private radiology practice) were asked to complete (pilot) the round one Delphi questionnaire. The resulting data, suggestions and (constructive) criticisms were analysed, and where applicable, assimilated into the Delphi questionnaire before being sent to the panel for the first round.

Piloting the questionnaire was done in an effort to ensure reliability, validity and trustworthiness.

3.2.2.8 *Data Gathering*

Prior to commencing the research, letters of invitation (*cf.* Appendix A1) were sent to selected individuals (*cf.* 3.2.2.3), requesting their participation in the Delphi questionnaire survey. All individuals who agreed to participate in the study had to sign a consent form (*cf.* Appendix A2) – letters of invitation and consent were conveyed electronically via email (with the option of receiving a hard copy of the letters via the postal services). After the completion of each round of the Delphi, the participants received feedback on the completed round, where after the next questionnaire, accompanied by a letter with instructions for that round of the survey, was sent out for completion. The Delphi questionnaires, instructional letters and feedback were sent to each panel member in electronic format via e-mail (again, with the option of receiving a hard copy of the letters via the postal services). The researcher then followed up with each participant to ensure receipt of the questionnaires. Round One of the Delphi survey commenced during October 2013; the survey concluded May 2014.

3.2.2.9 *Data Analysis*

A primary objective of the Delphi study is to obtain consensual and consistent opinions from a group of experts, in two or more successive rounds, on a given research subject. In most Delphi surveys, consensus is assumed to have been achieved when a certain percentage of the respondents indicate the same value (to a specific question) as their choice (Linstone & Turoff 2002:271). For the purpose of this study, consensus was claimed when 80% or more of respondents chose the same option on the Likert scale.

Linstone and Turoff (2002:271-271) describe a strong natural tendency for opinions to centralise and suggest that stability represents that point in the Delphi at which the response(s) may be said to be unchanged and, therefore, in a stable position. Because the interest lies in the opinion of the group rather than in that of individuals, overall stability is declared when movement of the opinion of the group as a whole has reached stability. The use of stability as a stopping criterion honours one of the original objectives of Delphi, namely the identification of areas of difference, as well as areas of agreement, within the participating group. Its use as a stopping criterion also allows more information to be derived from the Delphi, as it preserves opinion distributions and any well-defined disagreements that may exist (Linstone & Turoff 2002:275).

Analysis of the Delphi process was performed manually and by the same person (namely the researcher) in each of the rounds (*cf.* Chapter 4).

3.2.3 Semi-Structured Interviews

Semi-structured interviews generally are used by researchers to gain a detailed picture of a participant's ideas, beliefs, views or opinions of a particular phenomenon or topic, as the participant is allowed to give a fuller view than in a structured interview, due to the flexibility of the method (Greeff 2002:302). For this reason, this method of data collection was decided on in the study.

3.2.3.1 *Theoretical Aspects*

Interviewing, according to Shank (2002:42), is an act of conversing, and all acts of conversing involve the transfer of information. He goes on to explain that, unlike normal conversation, which presupposes a pattern of reciprocation, one that results in a specific symmetry of disclosure, in an interview, disclosure assumes a more asymmetrical pattern where one party seeks information and the other provides the information. Dunn (2005) in Longhurst (2010:105) explains that interviews are verbal interchanges between an interviewer and an interviewee, during which time the interviewer asks questions in an attempt to elicit information from the interviewee. Maree (2012:87) sees an interview as an opportunity to see the world through the eyes of the person being interviewed, which – when conducted qualitatively – can be a valuable source of rich, descriptive data.

According to De Vos *et al.* (2012:351-352) semi-structured one-to-one interviews are used to "gain a detailed picture of a participant's beliefs about, or perception or accounts of, a particular topic" and finds it particularly suited to situations where the researcher is interested in complexity or process. Dunn (2005) in Longhurst (2010:105) notes that, whilst there is a degree of predetermined order to semi-structured interviews, it still allows flexibility in the way issues are addressed by the informant. In this they differ from structured interviews that are directed by a predetermined and standardised list of questions, and also from unstructured interviews in which case the interview is directed by the informant rather than by the set of questions.

A semi-structured interview is a qualitative method of inquiry that combines a pre-determined set of open questions (questions that prompt discussion) with the opportunity for the interviewer to explore particular themes or responses further. The interviewer has a set of pre-determined core questions (related to the topic areas the researcher wants to cover) on an interview schedule; this schedule serves to guide, rather than dictate, the interview. This schedule of predetermined questions ensures that the same areas are covered with each interviewee. As the interview progresses the interviewee has the opportunity to elaborate or provide more information as the individual sees fit. The structure of the interview (or lack thereof) also allows the interviewer the freedom to elaborate on the original response or to follow a line of inquiry introduced by the interviewee; it also allows for new questions to be brought into the interview in response to information provided by the interviewee. Although many of the questions are created during the interview, the pre-planned core questions ensure a degree of consistency across the interviews.

In semi-structured interviews the quality of the data collected relies both on the interview design and the skill of the interviewer (De Vos *et al.* 2012:351-353).

3.2.3.2 *The Semi-Structured Interviews in this Study*

Prior to commencement of the research, permission and consent had to be obtained from the participants. A letter of invitation to participate in the semi-structured interviews (*cf.* Appendix B1) was sent to the selected respondents (*cf.* 3.2.3.3), followed by a consent form to participate in the interviews (*cf.* Appendix B2) to all respondents who had agreed to participate.

The semi-structured interview was chosen for its ability to deliver rich information by allowing the discussion of an individual's opinion and views. Interviewing a group of experts on a one-on-one basis also has the advantage of obtaining a majority opinion without any one opinion being influenced by the opinion of others in the group, resulting in more honest and reliable data.

Individual, one-on-one, semi-structured interviews where held with a selection of academic role-players – involved in postgraduate radiology training in South Africa – in order to discuss the proposed continued assessment programme. Information gained from the interviews was then used to refine the continued assessment programme.

3.2.3.3 *Target Population*

For the semi-structured interviews, the target population consisted of medical professionals involved in postgraduate radiology education in South Africa. In choosing the interviewees, individuals affiliated with the seven academic training units in South Africa and at the time involved in postgraduate radiology training were favoured. Preference was further given to individuals concerned with the ongoing assessment and examining (final summative assessment) of registrars enrolled in postgraduate diagnostic radiology training.

Individuals who had participated in the Delphi survey were also eligible for the semi-structured interviews; in as far as it was possible, however, the researcher made use of individuals who had not participated in the Delphi survey.

3.2.3.4 *Survey Population*

The survey population was composed of respondents who agreed to be interviewed and had completed, signed and returned the consent forms. This group consisted exclusively of medical practitioners in possession of a valid postgraduate degree in diagnostic radiology and who were actively involved in the training and assessment of registrars enrolled in radiology postgraduate studies at universities across South Africa (*cf.* 3.2.3.6). All interviewees were from South Africa, an important consideration given the context of the study.

3.2.3.5 *Sample Size*

The sample size represents the number of semi-structured interviews completed with full, written, informed consent. During the period August 2014 to November 2014, six semi-structured interviews were conducted with important role players in postgraduate radiology education and assessment (*cf.* 3.2.3.6 for the inclusion criteria).

3.2.3.6 *Description of the Sample*

In choosing suitable candidates for the semi-structured interviews, a selection matrix once again allowed the comparison of candidates to one another, based on criteria decided upon in consultation with the promoters. Participants were identified on the basis of a number of predetermined criteria, which included:

- Radiology qualification/ qualified radiologist.
- Minimum five years' postgraduate study.
- Practising as a radiologist.
- Private practice/ academic environment.
- Involved in radiology curriculum/ academic programme planning.
- Involved in radiology teaching.
- Radiology examiner or involved in radiology assessment.
- Examiner in radiology finals.
- Published or presented on radiology education.
- Published on radiology, nationally or internationally.
- Presented at international radiology congresses or workshops.
- Involved with the RSSA or College of Radiology (of South Africa).

Criteria for the exclusion of eligible candidates from the semi-structured interviews were stipulated as:

- lack of availability;
- not giving consent to participate; and
- being a possible examiner of the PhD thesis.

The aim was to interview individuals knowledgeable and experienced in the tuition and assessment of registrars in the context of postgraduate radiology education/training in

South Africa. The sample eventually comprised of experienced (more than five years postgraduate experience) graduate radiologists affiliated with five different South African academic radiology departments/universities and employed by the various provincial health departments on a full-time basis. An Internet search found radiology-related publications by all the radiologists, again mostly related to diagnostic radiology and not assessment. Evidence of presentations at international congresses or workshops was found for three of the candidates. Having senior specialists from the academic environment contributed to the validity and reliability of the interviews as these individuals are all actively involved in the teaching/training and assessment of radiology registrars and curricular planning of their various departments.

3.2.3.7 *Data Gathering*

The first step of the stage of the data gathering process involved sending out letters of invitation (*cf.* Appendix B1) to all potential interviewees (*cf.* 3.2.3.3), requesting their participation in the semi-structured interviews. Those individuals who agreed to participate in the semi-structured interviews did so by signing and returning the accompanying consent form (*cf.* Appendix B2). Both the letters of invitation and the consent forms were conveyed electronically via email (with the option of receiving a printed copy of the letters by post).

Interviews were scheduled by appointment and at the convenience of both interviewee and researcher. Interviews were scheduled in such a way that they could be conducted in a relaxed atmosphere, unrushed and without interruption; at least two hours were set aside for each interview. An interview guide – containing the interview questions and background information pertaining to the interview – was sent to each participant at least one week ahead of the scheduled interviews. This was done to allow the participants adequate time to consider the interview questions and thus prepare for the interviews.

Prior to commencing the interview, the researcher explained the aim of the study, as well as the purpose, nature and process of the interview to each interviewee. Participants were then given the opportunity to ask questions concerning the study, the interview and the informed consent.

All interviews were conducted in person, by the researcher and in either Afrikaans or English (depending on the preference of the individual being interviewed). In asking the questions, the researcher adhered to the predetermined sequence of questions adopted in the questionnaire. Whilst the interview was guided by the predetermined questions, interviewees were allowed the freedom to elaborate on their answers and extended discourse was encouraged. The interviews lasted 90 minutes on average. The duration of the interviews was sufficient to cover all aspects that both researcher and participants wanted to discuss.

With the full, written consent of the interviewees, all interviews where digitally recorded to allow subsequent transcription and referencing. The same person performed all transcribing. Once all the recorded interviews had been transcribed, both the researcher and one of the promoters reviewed the transcriptions, in order to ensure accuracy of transcription.

In addition to recording the conversations, field notes were made during and after the interviews in order to help remember and explore the process of the interview. Babbie (2007:310) in De Vos *et al.* (2012:359) warns that one should not trust your memory any more than you have to and suggests that both empirical observations (what you *know* has happened), and one's interpretation of these observations (what you *think* has happened), should be noted – observations and interpretations should however be kept distinct.

3.2.3.8 ***Data Analysis***

The transcriptions and audio recordings were controlled and accuracy verified by one of the promoters. The data were then analysed by the researcher according to qualitative data analysis methods.

The initial step involved coding the data (responses) acquired during the interviews. Saldaña (2009:4) describes this step as the "transitional process between data collection and more extensive data analysis". A code is a word or a concise phrase that captures the attributes (essence) of a specific portion of data. Coded data that share the same attributes are consequently grouped into categories and subcategories – this is referred to as codifying (Saldaña 2009:8). Grbich (2007), as quoted by Saldaña (2009:8), refers to codifying as the process of segregating, grouping, regrouping and relinking of data "in order to consolidate meaning and explanation". According to Saldaña, the process of coding, categorisation and subsequent analytical reflection can lead to the identification of themes within the collected data. Rossman and Rollis (2003) in Saldaña (2009:13) distinguishes between a category and a theme by referring to a category as a word or a phrase that describes an explicit segment of data, as opposed to a theme which they define as a phrase or a sentence that describes a more subtle and tacit process. Figure 3.1 describes a streamlined codes-to-theory model for qualitative inquiry – the process starts with real and particular data and transforms it into more abstract and general theory.

At the end of the analytical process, one of the promoters reviewed the codes, categories and themes identified by the researcher.

For a complete and detailed description of the data analysis *cf.* Chapter 5.

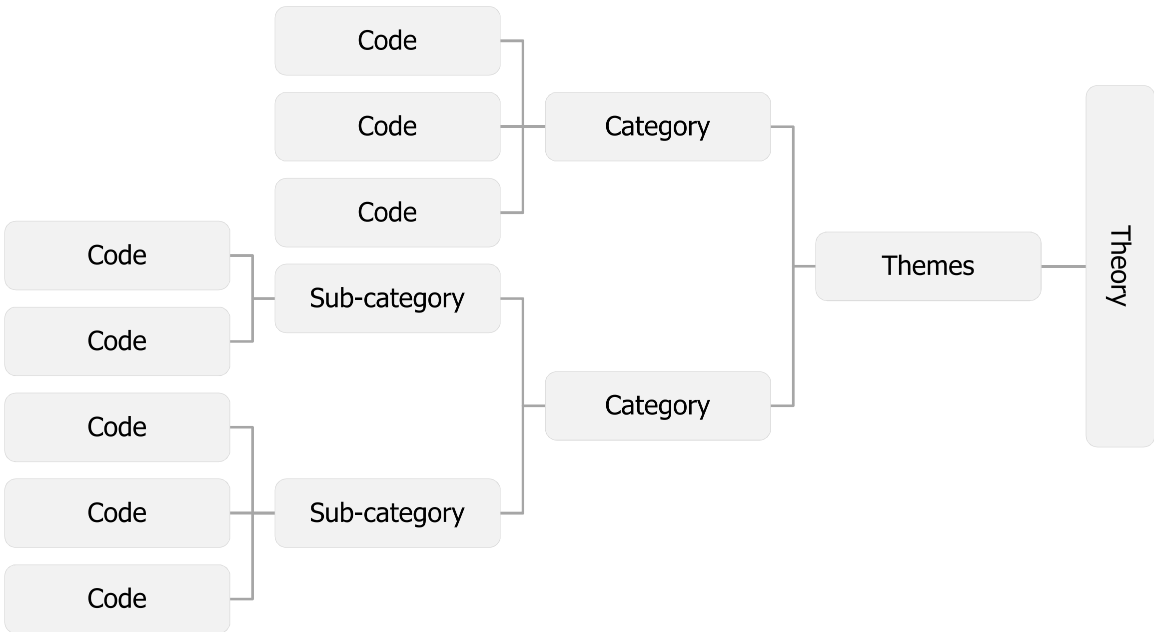

Figure 3.1 A streamlined codes-to-theory model for qualitative inquiry (taken from Saldaña 2009:12).

3.3 ENSURING THE QUALITY, RELIABILITY, VALIDITY AND TRUSTWORTHINESS OF THE STUDY

In an attempt to ensure the quality of the study attention was paid to the reliability, validity and trustworthiness of both the Delphi process and the semi-structured interviews. The rest of this section provides a discussion of these individual concepts and the actions taken to comply with these requirements.

3.3.1 Reliability

The reliability of a measuring instrument refers to the inherent consistency, stability and dependability of that instrument – it does not, however, concern itself with the subject matter being researched. A reliable measuring instrument will thus yield the same – or at least similar – results, when administered at different times or to different subjects from the same population, under the same conditions (De Vos *et al.* 2012:177; Maree 2007 in De Vos *et al.* 2012:178). Reliability lends credibility to the findings and creates confidence in the generalisability of the results from the research (Sandelowski 1986:33).

Neuman and Kreuger (2003) in De Vos *et al.* (2012:177), as well as Salkind (2006) in De Vos *et al.* (2012:177), have suggested ways in which to improve the reliability of a measurement, such as increasing the number of observations used to measure each aspect of the variable; eliminating statements and questions that are unclear; ensuring that the conditions under which the measurement is administered are standardised; moderating the difficulty of the measuring instrument in order to ensure an appropriate degree of difficulty whilst still measuring at the highest possible level; minimising external influences; making use of standardised instructions; ensuring consistency of the scoring procedure, and utilising pre-testing and pilot studies.

A relationship exists between reliability and validity, which holds that validity is a direct function of reliability (Guba 1981:81); reliability does not ensure validity; however, without reliability there can be no validity (Salkind 2006 in De Vos *et al.* 2012:178) – in other words, reliability is a necessary, yet insufficient, precondition to validity.

The reliability of a measuring method determines to what extent the instrument will produce the same or similar results when repeatedly administered under the same conditions – this criterion values repeatability and assumes that repeated administration of the test is possible and does not alter the subject being studied (Sandelowski 1986:33). Qualitative research places a premium on human uniqueness and the variations brought about by personal experiences, according to Sandelowski (1986:33). It is therefore easy to see how the control demanded by reliability can have a negative impact on qualitative research, and why authors such as Stenbacka (2001:552) argue that reliability as a criterion has no relevance in qualitative research and should be limited to discussions about the quality of quantitative research.

In the ERIC/ECTJ Annual Review Paper of 1981, Guba (1981:75-91) deals with the inappropriateness of using the same set of criteria to evaluate both quantitative and qualitative research. Guba (1981:81) explains that whereas the consistency of quantitative research depends on stability and invariance, the consistency of qualitative research depends on the auditability of the variances inherent to this type of research. He proposes the use of the term dependability, as opposed to reliability, when referring to the consistency of qualitative research. De Vos *et al.* (2012:420) explains that dependability takes into account the ever-changing conditions of the social world and the influence this has (may have) on the subject under scrutiny. In qualitative research, where the researcher is interested in the diversity and characteristics of the variables being studied, the question is not whether the results are reproducible and consistent, but rather whether the research process is logical, well documented and audited (De Vos *et al.* 2012:420).

Lincoln and Guba (1985) in Golafshani (2003:601) propose inquiry audits as a way of enhancing the dependability of qualitative research; an inquiry audit involves enlisting an outside expert auditor to verify the consistency of the research process and the product of the research inquiry (Golafshani 2003:261). Stenbacka (2001:552) agrees that a thorough description of the entire process should contribute to the quality and dependability of a qualitative research project.

Measures to ensure reliability in the Delphi survey involved a well-constructed Delphi questionnaire, piloted and reviewed by experts in this area of research, the use of carefully selected criteria in the selection of Delphi participants and having measures in place to ensure a high response rate. In terms of the semi-structured interviews, careful selection of core questions for the interviews (reviewed by experts in this field of research), combined with a clear understanding of what the interviewer wanted from the interviews and the meticulous and careful selection of the interviewees contributed to dependability. Providing a thorough description of the whole process, enabling conditional inter-subjectivity and allowing for internal auditing further enhanced the dependability of the study.

3.3.2 Validity

Leedy and Ormrod (2005) in De Vos *et al.* (2012:173) define the validity of a measuring instrument as "the extent to which the instrument measures what it is supposed to measure" – in other words – does the instrument do what it supposed to do, and does it do so accurately? (De Vos *et al.* 2012:173). De Vos et al. (2012:173-175) discuss four different validities underlying measurement:

- *content validity* defines the sampling adequacy of the measuring instrument, which is determined by the representativeness of the sample, of the elements and/or content of the phenomenon under study;
- whereas content validity deals with what the instrument actually measures, *face validity* merely refers to what the instrument appears to be measuring;
- both content and face validity may be established prior to data collection.
- *criterion validity* seeks objective proof of validity by comparing the results of the measurement (research) against appropriate external or independent criteria – believed to be reliable and valid – for the phenomenon being studied;
- *construct validity* validates not only the measuring instrument, but also the theory behind the instrument and its use (construct validity is enhanced when the findings of the study is in line with theoretical explanations of the phenomenon being studied (Krefting 1991:30);
- only once the instrument has been selected and the data has been collected, can conclusions be made about both criterion and construct validity.

The trustworthiness of quantitative research relies heavily on both internal validity and external validity of the measuring instrument (Maree 2012:151).

Internal validity defines the relationship between the findings of the study and the phenomenon being studied, and is influenced by the effect the investigative procedure has on the findings (Krefting 1991:29). Krefting (1991:29) holds that research is internally valid when the results of the research are characteristic of the subject(s) being investigated and not of the investigative procedure per se; it lends confidence to the premise that the research findings were not (significantly) influenced by the actual process of investigation (research), but only by the subject(s) or variable(s) that were investigated.

External validity, according to Krefting (1991:31), refers to the generalisability of the research results to the entire population. Research is externally valid when the conditions of the research are comparable to conditions in the natural world (Krefting 1991:31). External validity therefore allows the generalisation of the research findings outside the study to other (real life) situations and to other people (Maree 2012:151).

Many qualitative researchers have argued that the term validity does not apply to qualitative research that has resulted in a confusing array of alternatives to validity in qualitative research (Creswell & Miller 2000:124) – not surprising when one considers that qualitative research refers to many dissimilar research methods which all have different ways of determining trustworthiness (Krefting 1991:215). The work of Guba (1981) has relevance; in 1981 Guba proposed a model based on four aspects of trustworthiness relevant to both quantitative and qualitative research. In this model he proposes the use of credibility when referring to the truth value of qualitative research (as opposed to internal validity which applies to quantitative research) and transferability when referring to applicability in qualitative research (as opposed to external validity which applies to quantitative research) (*cf.* 3.3.3 and Table 3.1). Creswell and Miller (2000:124) suggest that, choosing how to establish validity in a study depends on the researchers' perceptions of validity and their choice of paradigm assumption. Procedures employed to ensure validity in qualitative research include member checking, triangulation of different methods, disconfirming evidence, researcher reflexivity, thick and rich description, prolonged engagement and persistent observation in the field, peer review and debriefing, collaboration with participants and external audits (Creswell & Miller 2000:124-129).

Methods to ensure and improve validity in this study depended on a strong and thorough literature overview and a highly controlled, truly experimental design including the use of pilot studies and securing the involvement of carefully selected experts in both the Delphi survey and the semi-structured interviews. Goodman (1987:731) argues that content validity can be assumed, provided the panellists participating in the Delphi study are representative of the group or area of knowledge under study; this, however, places a responsibility on the researcher to prove and verify the selection procedure. Further measures to enhance validity, more specifically aimed at the qualitative component of the study, involved triangulation, peer debriefing and rich description.

3.3.3 Trustworthiness

In the article *Rigor in Qualitative Research: The assessment of Trustworthiness*, Krefting (1991:214) raises the following issues: firstly, that the worth of quantitative research is valued in terms of reliability and validity; secondly, that the models used to assess the worth of quantitative research do not apply to qualitative research; and thirdly, that qualitative research encompasses a variety of dissimilar research methods and for this reason, not all qualitative research can be assessed in the same way.

As mentioned above, in 1981, Egon G. Guba (seminal author in the fields of evaluation and qualitative research) published an article about the criteria for assessing the trustworthiness of research conducted within the naturalistic inquiry paradigm, in which he proposes a new model for assessing the trustworthiness of qualitative data. The model identifies four aspects of trustworthiness relevant to both quantitative and qualitative studies (Guba 1981:79-82). The four quality criteria are truth value, applicability, consistency and neutrality (*cf.* Table 3.1). Guba (1981) argues that, based on the philosophical and conceptual differences between quantitative and qualitative research, the four criteria should be defined differently for each approach (Krefting 1991:217). Table 3.1 – compiled by Krefting (1991:217) – gives a summary of the quality criteria, their common quantitative definitions and Guba's qualitative definitions – adapted from Guba (1981:80).

Table 3.1 Comparison of criteria by research approach (taken from Krefting 1991:217).

CRITERION	QUANTITATIVE APPROACH	QUALITATIVE APPROACH
Truth value	Internal validity	Credibility
Applicability	External validity	Transferability
Consistency	Reliability	Dependability
Neutrality	Objectivity	Confirmability

Truth value depends on the researcher establishing confidence in the truth of the findings of a particular study, based on the research design of that study, the respondents involved in the inquiry and the context in which the research was undertaken (Guba 1981:79; Krefting 1991:215).

The truth value of quantitative research is reflected in how well threats to the internal validity of the study have been managed – that, and the validity of the investigative instrument as a measure of the phenomenon being studied (Sandelowski 1986:29). *Cf.* 3.3.2 for more on internal validity. Factors that threaten internal validity include selection, selection bias, pretesting, instrumentation, attrition, historical factors, maturation or change in subjects and statistical regression (Maree 2012:151-152).

In qualitative research, on the other hand, truth value comes from discovering human experiences as they are lived and perceived by the respondents (Sandelowski 1986:30). Slevick (1971) in Sandelowski (1986:30) holds that in qualitative research the truth is subject-orientated and not dependent on the verification of a researcher-defined concept of the human experiences. Credibility, according to De Vos *et al.* (2012:419-420) describes the adequacy and accuracy of a researcher's reconstruction and representation of a participant's views and opinions.

The most important technique for establishing credibility in the findings of a study, involves a process referred to as *member checking* (Guba 1981:80). Member checking involves returning the data to the participants of the study, in order for them to confirm the credibility of the observations, interpretations and deductions made during the inquiry (Creswell & Miller 2000:127).

Applicability refers to the application of the findings from the inquiry to other groups and or different settings and contexts; in short, generalising the findings outside the confines of the study (Krefting 1991:216).

In quantitative research, applicability refers to how well threats to *external validity* have been managed (Sandelowski 1986:31). Factors that threaten external validity include insufficient realism, ecological validity, demand effect, instrumentation, reactions to experimental conditions and failure to describe independent variables explicitly (Maree 2012:152).

Qualitative research is conducted in a naturalistic setting, with few controlling variables, where it aims to discover and describe a particular experience or phenomenon – the characteristics of which is intimately linked to the conditions under which it is discovered (Guba 1981:80). It is therefore not difficult to understand why generalisability to other settings may be problematic (De Vos *et al.* 2012:420), which is why Guba presents *transferability* as the criterion with which to assess the applicability of qualitative data (Guba 1981:81); keeping in mind that transferability depends on the degree of similarity between two settings (Guba 1981:81).

Lincoln and Guba (1985) in Krefting (1991:216) place the responsibility of transferability on the individual who wants to apply the findings of the study to another setting, context, person or population. The researcher's responsibility, in terms of ensuring transferability, lies in providing sufficient descriptive data (which includes the theoretical parameters of the research) to allow comparison (Krefting 1991:216).

The third criterion of trustworthiness, as the name suggests, assesses the consistency of the findings of an inquiry. **Consistency** considers whether findings would remain unchanged if the research were to be repeated with the same subject(s) or in similar circumstances (Krefting 1991:216). This involves the stability of investigative findings; an important aspect of research, according to Guba (1981:81), who affirms that results have to be stable in order to be meaningful.

In quantitative research, *reliability* is the criterion concerned with the stability, consistency and dependability of an investigative procedure (Sandelowski 1986:32). Reliability assumes that there is an observable regularity about human experiences and that the investigative procedure can be repeated, without altering the phenomenon or subject being studied – this implies that replication of the investigative procedure can produce consistent results that are a product of the phenomenon or subject being studied, and not the study itself (Sandelowski 1986:33). Such reliability, according to Duffy (1985:230) is dependent upon a tightly designed and restricted method of observation. For more information on reliability *cf.* 3.3.1.

Qualitative research, on the other hand, is grounded in unstructured and often spontaneous strategies of inquiry (Duffy 1985:230). Qualitative inquiry concerns itself with the uniqueness of the human condition and the richness of information locked up in variability of individual experiences – it is not interested in identical repetition

(Sandelowski 1986:33); because qualitative researchers embrace variability, reliability (as a measure of consistency) cannot be applied to qualitative research. Guba (1981:81) consequently suggests the use of the term *dependability* when assessing the consistency of qualitative research. Dependability represents a concept, which embraces trackable variance (variability that can be ascribed to identified sources) whilst at the same time adopting elements of stability implied by reliability (Guba 1981:81).

Neutrality, according to Sandelowski (1986:33), refers to the freedom from bias in the research process and results. Guba (1981) in Krefting (1991:216) describes it as the degree to which findings are the function solely of the informants and the conditions of the research.

In quantitative research, this freedom from bias is assessed is termed *objectivity* (Guba 1981:81). Objectivity in quantitative research depends on the rigour of methodology and the proper distance between the observer (investigator) and the subject being observed (investigated), in order to minimize the influence of the researcher on the study and vice versa (Krefting 1991:217) – the latter is referred to as scientific objectivity or being scientifically distant. According to Sandelowski (1986:33), quantitative objectivity can be claimed once validity and reliability has been established.

Lincoln and Guba (1985) in Krefting (1991:217) emphasise the neutrality of the data (as opposed to the neutrality of the researcher). They contend that qualitative investigators intentionally minimise the distance between themselves and the subject being investigated, in order to increase the meaningfulness of their findings. This contradicts the scientific objectivity observed by quantitative inquirers. With this in mind, Guba (1981:81) proposes *confirmability* as the criterion of neutrality in qualitative research. Confirmability, explains Guba and Lincoln (1981) in Sandelowski (1986:34), refer to the findings themselves, and can be achieved through establishing both truth value and applicability (Krefting 1991:217).

A major technique for establishing confirmability involves auditing the product (Guba 1981 in Krefting 1991:221). An external auditor reviews both the process and products of the research including raw data, data reduction and analysis products, data reconstruction and synthesis products, process notes, materials related to intentions and dispositions and instrument development information (Guba & Lincoln 1985 in Krefting 1991:217).

In this study trustworthiness was addressed through the use of reliable and valid research instruments, namely the semi-structured interviews and the Delphi survey. The latter brings with it the credibility of the Delphi instrument, the Delphi method of research and the expertise of the Delphi panel. Individual and collective written feedback of the results after each and every round of the Delphi study further enhanced trustworthiness. In terms of the semi-structured interviews, data from the interviews were transcribed, after which the researcher and one of the promoters compared the transcriptions to the original audio recordings in an attempt to ensure accuracy.

An accurate and adequate description of the theoretical parameters of the research, as well as a complete and detailed set of records of all phases of the process further adds to the trustworthiness of the research study.

3.4 ETHICAL CONSIDERATIONS

3.4.1 Approval

Permission to conduct this Ph.D. study was obtained from the Ethics Committee of the Faculty of Health Sciences (Ecufs no 80/2013) at the University of the Free State (UFS). The allocated Ethics Committee number was used on all documents and correspondence pertaining to the study. Permission was also obtained from the Faculty Management Committee and the Executive Committee of the School of Medicine (SoM). Approval for the study was also obtained from the Vice-Rector, Academic Planning, University of the Free State.

3.4.2 Informed Consent

Written informed consent (*cf*. Appendix A2 and B2) was obtained from all participants involved in the Delphi survey and the semi-structured interviews. A short overview of the study and its purpose, as well as an explanation of what was expected of the participant, was provided to all individuals prior to their participation. The researcher also assured each participant involved in the research, in writing, that their information would remain confidential and be known only to the researcher and the promoters.

3.4.3 Right to Privacy

The information collected during both the Delphi survey and the semi-structured interviews were dealt with in the strictest confidence. Only the researcher and promoters were privy to the information pertaining to the Delphi respondents and semi-structured interviewees, and the data collected from the Delphi process and semi-structured interviews. Where it formed part of the research methodology, information gathered during the research was rendered anonymous before being passed on to participants and respondents.

Under no circumstances were any personal details pertaining to the participants of either the semi-structured interviews or the Delphi survey, revealed to outside parties. This was necessary to prevent the authority, personality or reputation of some participants from dominating others in the process. Answers, opinions, views and suggestions obtained during individual semi-structured interviews were treated in confidence, in order to eliminate bias and critique and allow free expression of opinions. By the nature of the Delphi process, information gathered during the various Delphi rounds had to be made available to the participants in the follow-up rounds. This information, however, reflected the views and opinions of the group as whole and individual views and opinions were not revealed. This was done to allow individuals the freedom of expression and revision of views and opinions.

No respondent names appeared on any documentation and where necessary, code numbers were used.

3.5 CONCLUSION

Chapter 3 provided an overview of the research methodology applied in the study and the procedures that were followed.

In the next chapter, Chapter 4, entitled **Discussion of the Results: Delphi Questionnaire**, the results of the Delphi process will be reported and discussed.

CHAPTER 4

DISCUSSION OF THE RESULTS: DELPHI QUESTIONNAIRE

4.1 INTRODUCTION

The results and key findings of the Delphi survey are reported in this chapter. The results are presented in a manner corresponding to the different rounds of the Delphi process. The Delphi technique and theoretical underpinnings were described in Chapter 3 (*cf.* 3.2.2).

4.2 DISCRIPTION AND DISUSSION OF THE DELPHI SURVEY

The results and findings of each consecutive Delphi round are subsequently presented. This is followed by a summative discussion of the outcome of the Delphi survey at the end of the chapter.

4.2.1 Round One of the Delphi Survey

This section delivers an overview of the process followed and includes explanatory notes on the different sections, subsections, number of statements in each section and the measuring scales used; this will be complemented by a summary of the results and an analysis of the responses.

4.2.1.1 *The Measuring Instrument*

In addition to the Round One questionnaire, each participant received an instructional letter (*cf.* Appendix A3). The letter explained the structure of the questionnaire and contained instructions on the completion of the questionnaire. All documentation was sent electronically by e-mail (as per indicated preference from each of the Delphi panellists).

What follows is a discussion of the questionnaire design. This will be done once only, as the basic structure of the questionnaire remained the same throughout the survey. Amendments made to the questionnaire during the course of the survey will be discussed under the appropriate section.

Section A of the Delphi questionnaire was entitled **THE CURRICULUM** (*cf.* Appendix A7) and dealt with the exit-level outcomes expected of a graduate in Diagnostic Radiology (in the context of postgraduate radiology training in South African); these included outcomes related to knowledge and behaviour as well as practical skills. Section A was divided into thirteen subsections (n indicates the number of statements included in each subsection):

- A - Breast Imaging (n=46)
- B - Cardiac Imaging (n=20)
- C - Thoracic Imaging (n=51)
- D - Gastrointestinal Imaging (n=76)
- E - Nephrology and Urology Imaging (n=56)
- F - Gynaecological Imaging (n=37)
- G - Obstetric Imaging (n=14)
- H - Neurological Imaging (n=63)
- I - Extracranial Head and Neck Imaging (n=40)
- J - Musculoskeletal Imaging (n=52)
- K - Paediatric Imaging (n=47)
- L - Vascular Imaging (n=62)
- M - Non-Radiological Skills (n=55)

Each subsection was further divided into Headings One and Two. Heading One of each subsection dealt with the knowledge a registrar is expected to have acquired by the end of his/her training period – the length of the training period was not defined as there is no uniformity with regard to the radiology training programmes presented by the different academic institutions across South Africa. Heading Two of each subsection addressed the skills (practical, knowledge and behaviour) a registrar is expected to have mastered by the end of his/her training period – again, the length of the training period was not defined.

The section under each heading of each subsection of Section A contained numerous statements (*cf.* n value assigned to each subsection in the A to M tabulation above – total for Section A = 619) that had to be judged according to answers presented in a three-point Likert scale.

Under Heading One, the three possible answers were defined as:

1. **Advanced** - the candidate is expected to have an advanced/expert knowledge of this subject, which in this case implies a broader and more detailed knowledge than what can be expected with a basic knowledge.
2. **Basic** - a basic knowledge of this subject is adequate; a basic knowledge, in this case refers to a level of knowledge (about the subject) equivalent to the level of knowledge presented in a general reference radiology textbook such as *Grainger & Allison's Diagnostic Radiology*.
3. **Unnecessary** - knowledge of this subject is not essential/optional and the registrar will not be assessed on this topic, neither will questions about this topic be included in the final examination.

Respondents were instructed to choose only one of the three possible answers with regard to each statement, and to answer all the questions.

Heading Two similarly presented three possible answers to each statement:

1. **Advanced** - an advanced skill level allows an individual to safely and competently perform a procedure/skill on his/her own – without supervision – and also qualifies them to teach or train colleagues.
2. **Basic** - a basic skill level implies that the registrar has enough knowledge and skill to perform a procedure under supervision and with (or without) assistance.
3. **Unnecessary** - this skill is not essential/optional and the registrar will not be assessed on this topic, neither will questions about this topic be included in the final examination.

Respondents were again instructed to choose only one of the possible answers and to answer all questions. The questionnaire allowed for comments from the respondents adjacent to each statement. Additional space was also provided at the end of each heading for more detailed comments and or suggestions regarding the topics dealt with in the preceding section.

Respondents were furthermore informed that Section A did not address physics, pathology or anatomy as separate entities, but focused instead on diagnostic radiology as the main subject in postgraduate radiology training (which in itself may include references to anatomy, physics and procedural aspects where applicable), and that the questionnaire did not aim to give a detailed description of the theoretical knowledge a graduate has to acquire.

Section B of the questionnaire was titled **CONTINOUS ASSESSMENT** (*cf.* Appendix A7) and addressed the in-training continuous formative assessment of a registrar during his/her training period. It was explained that this section of the questionnaire aimed to inform the structure and content of a continuous assessment programme that spans the entire training programme; a programme consisting of several assessments, employing different assessment tools, and effected at predetermined times during the syllabus. Section B consisted of seven subsections (n indicates the number of statements included in each subsection):

- A - Fluoroscopy (n=25)
- B - Ultrasound (n=56)
- C - Computed Tomography (n=26)
- D - Magnetic Resonance Imaging (n=39)
- E - Breast Imaging (n=22)
- F - Interventional Radiology (n=65)
- G - Assessment Schedule (n=7)

With the exception of G, all the subsections assigned to Section B contained numerous statements (*cf.* n value assigned to each subsection in the A to F tabulation above – total for Section B = 240) that had to be judged against possible answers presented in a four-point Likert scale. Through their choice of answer, respondents indicated at what stage of the training they expected a registrar to have mastered that particular skill (either knowledge or a practical/procedural skill). The four possible answers were defined as:

1. **End of year one** – based on the premise that a registrar will have rotated through all imaging modalities at least once after one year.
2. **End of year three** – in line with the core curriculum of three years as adopted by many of the curriculums abroad.
3. **End of year five** – this refers to the end of the final year of a five-year radiology training programme: in terms of a four-year radiology training programme this equates to the end of year four (*i.e.* the final year)

4. **Not necessary** - you do not believe that is necessary for a registrar to have achieved competence in this skill at any point and should therefore not be formally assessed in terms of competence.

Subsection G (*cf.* Appendix A7) on the other hand, dealt with assessment related to the different radiology modalities (ultrasound, computed tomography, magnetic resonance imaging, fluoroscopy and interventional radiology – breast imaging was also included as a separate modality) and not with individual skills (as does the rest of the subsections). Here respondents had to consider the question, 'when should a registrar be assessed' before choosing one of the five possible answers:

1. once – after the first rotation;
2. once – at any time during the training period (before the final examination);
3. after each rotation;
4. after the first rotation and again at anytime during the training period (before the final examination); or
5. yearly.

Respondents were once again instructed to choose only one of the possible answers and to answer all questions. The questionnaire made provision for comments adjacent to each statement. Once more, additional space at the end of each subsection allowed for more detailed comments and or suggestions from the respondents.

4.2.1.2 *Analysis of the Round One Responses*

The responses obtained from the Delphi participants were analysed manually by calculating and documenting the distribution of responses to each statement. Consensus was claimed where 80% of the respondents chose the same option (to a specific statement) on the Likert scale; "consensus on a topic can be decided if a certain percentage of the votes falls within a prescribed range" (Miller 2006 in Hsu & Sandford 2007:4). In some instances a respondent neglected to answer a particular statement. In such cases, consensus was still calculated on the original number of respondents; this occasionally led to a question being re-submitted in the next round. Where consensus was achieved, the statement was eliminated from the survey and therefore excluded from the next round, in this case the Round Two questionnaire.

4.2.1.3 *The Findings of Round One of the Delphi Survey*

Of the initial eleven members of the Delphi panel, ten completed and returned the Round One questionnaire resulting in a response rate of 91%. Following Round One, consensus was reached in **38,7%** of the statements presented in the questionnaire – Section A 42,2% and Section B 29,7% (*cf.* Table 4.2).

Following the analysis of the Round One questionnaire, a feedback letter was dispatched to each of the ten participants, informing them of the consensus achieved during Round One. The feedback letter was accompanied by a copy of the questionnaire in which all statements where consensus had been reached were shaded in yellow, indicating their elimination from the survey. As agreed upon by the promoters and researcher, no individual comments were acknowledged or discussed in the correspondence. Participants were informed that all comments had been noted and documented and where comments were not directly addressed in the further rounds of the Delphi process, they would be referenced and discussed in the PhD document – either individually or, in cases where comments overlap, collectively.

4.2.2 Round Two of the Delphi Survey

As in the previous section, the measuring instrument used during Round Two of the Delphi survey and the method of analysis will be discussed, and the findings reported.

4.2.2.1 *The Measuring Instrument*

A few days after sending out the feedback on Round One, ten Round Two questionnaires (*cf.* Appendix A7) were dispatched to the remaining Delphi panel. The document stated the purpose of Round Two and provided instructions on the completion of the questionnaire (*cf.* Appendix A4). The Round Two questionnaire did not include any questions eliminated during Round One. It also did not contain any indication of the responses to any of the questions from Round One, in order to avoid influencing the participants at this stage. Respondents were encouraged to review their previous answers and, where they so wished, change their responses from Round One.

The following changes were made to the questionnaire before being sent out as Round Two:

Section A Subsection C2 (Thoracic Imaging):

- a2: *fluoroscopic diaphragm screening* – introduced into the questionnaire;
- a3: *HRCT for interstitial lung disease* – introduced into the questionnaire;
- a6: *VQ scan for pulmonary embolism* – introduced into the questionnaire;
- a7: *PET CT* – introduced into the questionnaire.

Review of the Round One questionnaire revealed relevant omissions, which were included in the Round Two questionnaire for completeness.

Section A Subsection F2 (Gynaecological Imaging):

- e7: *transabdominal pelvis ultrasound* – introduced into the questionnaire;
- e8: *endovaginal gynaecological ultrasound* – introduced into the questionnaire;
- e9: *MRI pelvis* – introduced into the questionnaire;
- i: *Perform uterine artery embolisation* – introduced into the questionnaire.

Review of the Round One questionnaire revealed relevant omissions, which were included in the Round Two questionnaire for completeness.

Section A Subsection G2 (Obstetric Imaging):

- c: *Perform transabdominal first trimester obstetric ultrasounds* – AIUM guidelines removed from the questionnaire;
- d: *Perform transvaginal first trimester obstetric ultrasounds* – AIUM guidelines removed from the questionnaire;
- e: *Perform second or third trimester obstetric ultrasounds* – AIUM guidelines removed from the questionnaire.

The AIUM guidelines were initially including as a representative example only. The uses of these specific guidelines were questioned – after careful consideration the researcher chose to omit the guidelines for the remainder of the survey.

Section A Subsection H2 (Neurological Imaging):

- j5: *MR diffusion imaging* – the word *perfusion* replaced with *diffusion*;
- j11: *CT myelography* – separated from j6 which previously read *conventional myelography and CT myelography*;
- j12: *MR functional imaging* – introduced into the questionnaire.

Review of the Round One questionnaire revealed grammatical oversights that were corrected in the Round Two questionnaire.

Section A Subsection K2 (Paediatric Imaging):

- b: *ultrasound for posterior urethral valves* – removed from the questionnaire;
- b2: *renal ultrasound (renal, bladder and pelvis)* – introduced into the questionnaire;
- c: *upper GIT studies* – removed from the questionnaire;
- c: *lower GIT studies* – removed from the questionnaire;
- c: *gastro-oesophageal studies* – removed from the questionnaire;
- c: *anorectal malformation studies* – removed from the questionnaire;
- c1: *upper GI study with small bowel series* – introduced into the questionnaire;
- c2: *barium enema (including anorectal malformation studies)* – introduced into the questionnaire;
- c5: *oesophagram* – introduced into the questionnaire.

The changes (*cf.* b and c) represent improvements to the description of statements included in the Round One questionnaire – no real new concepts or statements were introduced.

Section A Subsection L2 (Vascular Imaging):

- d2: *carotid ultrasound* – the researcher neglected to include the statement in any of the further rounds despite not reaching consensus during Round 1.

Section B Subsection B1 (Ultrasound):

- c: *Transabdominal pelvic ultrasound* – substituted for *assessment of female pelvic viscera*;
- j: *Transabdominal obstetric ultrasound first trimester* – did away with AIUM guidelines;
- k: *Transabdominal obstetric ultrasound second trimester* – did away with AIUM guidelines;
- k a: *Transabdominal obstetric ultrasound third trimester* – separated third trimester from second trimester (B1k);
- m: *Endovaginal obstetric ultrasound first trimester* – did away with AIUM guidelines;
- n: *Endovaginal obstetric ultrasound second trimester* – did away with AIUM guidelines;
- na: *Endovaginal obstetric ultrasound third trimester* – separated third trimester from second trimester (B1n);
- zb: *pylorus ultrasound* – removed from the questionnaire;
- zb: *ultrasound for intussusception* – removed from the questionnaire;
- zb: *urological ultrasound (including ultrasound for posterior valves)* – removed from the questionnaire;
- zb: *ultrasound for paediatric neck masses* changed to *ultrasound of the neck*;
- zb: *ultrasound of the hip for DDH and joint effusions* changed to *hip ultrasound*;
- zb1: *abdominal ultrasounds (includes identification of intussusception, pyloric stenosis and appendicitis)* – introduced into the questionnaire;
- zb2: *renal ultrasound (renal, bladder and pelvis)* – introduced into the questionnaire;
- zb3: *transabdominal pelvis ultrasound* – introduced into the questionnaire;
- zb6: *scrotal ultrasound* – introduced into the questionnaire.

Once more, the changes (*cf.* zb) represent improvements to the description of statements included in the Round One questionnaire – no real new concepts or statements were introduced.

4.2.2.2 *Analysis of the Round Two Responses*

Data from the Round Two questionnaires were analysed manually by calculating and documenting the distribution of response to each statement. Consensus was again claimed where 80% of the responses to an individual statement were congruent. Consensus once more resulted in the elimination of that statement from the survey and any subsequent questionnaires.

4.2.2.3 *The Findings of Round Two of the Delphi Survey*

Nine of the ten questionnaires where completed and returned; a response rate of 90% for Round Two and 82% for the entire survey thus far. Following analysis of the Round Two data, consensus was reached in **57,3%** of the statements – section A 65,1% and section B 37,2% (*cf.* Table 4.2).

As in Round One, the results from Round Two were conveyed to the remaining nine Delphi panellists by way of a feedback document. The feedback letter was again accompanied by a copy of the questionnaire with all statements on which consensus had been reached having been shaded - *yellow* for consensus during Round One and *green* indicating consensus during Round Two (*cf.* Appendix A7). Once again, no individual comments were acknowledged or discussed in the correspondence.

4.2.3 Round Three of the Delphi Survey

Round Three essentially mirrored Round Two, with the Round Three questionnaire succeeding the Round Two feedback document.

4.2.3.1 *The Measuring Instrument*

The Round Three questionnaire was mailed electronically (as were all the previous documents) to the nine remaining panellists. As with the previous rounds, the document stated its purpose and gave instructions with regard to the completion and return of the questionnaire (*cf.* Appendix A5).

The document also drew attention to amendments made to the Likert scale of Section B (*cf.* Appendix A5) – the choices presented in the Likert scale had been reduced from four down to three and were defined as follow:

1. The **first half of the training period** - a period defined by (the initial) 50% of the total training period irrespective of the length of the training period.
2. The **second half of the training period** - a period defined by (the latter) 50% of the total training period irrespective of the length of the training period.
3. **Not necessary** - you do not believe that is necessary for a registrar to have achieved competence in this skill at any point and should therefore not be formally assessed in terms of competence.

Section B requires the respondent to indicate at which stage of the training period they expect a registrar to have achieved competence in terms of a particular skill (whether it is knowledge or a practical/procedural skill). The poor consensus in Section B (30% after Round One and 37% following Round Two) through the first two rounds of the Delphi survey prompted a discussion between the researcher and his promoters. The deliberation identified a potential problem with the definition of the choices presented along the Likert scale. The postgraduate radiology syllabus at the UFS is devised around a five-year platform, which enables the fragmentation of the training period into one, three and five years. This accommodates the principle of the international three-year core curriculum in radiology. The problem arises when one attempts to project the four-year syllabus (used by most universities in South Africa) onto a five-year Likert scale. It was subsequently decided to combine option one (defined as end of year one) and option two (defined as end of year three) into an amended option one (defined as the first half of the training period). Option three was changed to option two and redefined as the second half of the training period option, whilst option three (not necessary) remained unchanged. This amended division (*cf.* Table 4.1 on page 135) applies itself better to the diverse conditions in South Africa.

In was also agreed upon to retain the answers where consensus had been reached during the first two rounds – option one and two statements were transferred to option one (as per definition used in Round Three) and option three choices were logged under option two (as per definition used in Round Three); option three statements were not influenced.

Questions on which consensus had been reached thus far were excluded from the Round Three questionnaire, as were any previous responses or comments.

Table 4.1 A depiction of the amendments made to the Likert scales between Rounds Two and Three.

<table>
<tr><th colspan="2">LICKERT SCALE OPTIONS DURING ROUND ONE AND TWO</th><th colspan="2">AMENDED LICKERT SCALE OPTIONS DURING ROUND THREE</th></tr>
<tr><td>Option 1</td><td>End of year one</td><td rowspan="2">Option 1</td><td rowspan="2">First half of the training period</td></tr>
<tr><td>Option 2</td><td>End of year three</td></tr>
<tr><td>Option 3</td><td>End of year five</td><td>Option 2</td><td>Second half of the training period</td></tr>
<tr><td>Option 4</td><td>Not necessary</td><td>Option 3</td><td>Not necessary</td></tr>
</table>

4.2.3.2 *Analysis of the Round Three Responses*

The responses from respondents were once again analysed manually by calculating the frequency of responses to each statement on the Likert scale.

4.2.3.3 *The Findings of Round Three of the Delphi Survey*

This time round all nine Delphi panellist completed and retuned the Round Three questionnaire; a response rate of 100% for this round. Analysis of the data from Round Three revealed that consensus had been reached in **70,7%** of the statements. Following the changes to the Likert scale in Section B (*cf.* 4.2.3.1), consensus increased from 37,2% (in the previous round) to 64,0% – consensus in Section A went from 65,1% to 73,2% (*cf.* Table 4.2).

Results were conveyed to the nine respondents through a feedback document. The feedback letter was accompanied by a copy of the questionnaire in which all the statements that had been eliminated through the various rounds were shaded in either yellow (Round One), green (Round Two) or blue (Round Three) (cf. Appendix A7). There was again no need to acknowledge or discuss any comments in the correspondence.

4.2.4. Round Four of the Delphi Survey

Round Four represents the last round of the Delphi survey. Round Four differs from the previous rounds in that it provided the Delphi participants with additional information to aid in the convergence of opinion towards consensus.

4.2.4.1 *The Measuring Instrument*

The Round Four Delphi questionnaires were dispatched a few days after the feedback from Round Three had been mailed (electronically) to the Delphi panellists. Apart from communicating the purpose of Round Four the document instructed the respondents in the completion and return of the questionnaires (*cf.* Appendix A6). The questionnaire, in keeping with the previous rounds, contained only those questions on which consensus had not been reached. In addition, a percentage scale in the comment column next to each statement identified how many respondents chose which particular option for that statement in the previous round, essentially providing an overview of the distribution of opinions across the Likert scale. It was made clear that this information served only to inform the reader and that they were not *expected* (although they were free to do so) to change their opinions in direct response to the statistics.

4.2.4.2 *Analysis of the Round Four Responses*

Responses from the Round Four questionnaires were analysed, documented and calculated manually. Where 80% of the responses to a specific statement were identical, consensus was claimed and the statement eliminated from the survey.

4.2.4.3 *The Findings of Round Four of the Delphi Survey*

All questionnaires were completed and returned resulting in a 100% response rate for Round Four and an 82% response rate for the entire survey. Following Round Four, consensus had been achieved in **88,4%** of the statements (89,6% in Section A and 85,4% in Section B).

The results from Round Four were conveyed to the Delphi participants by way of a feedback document. In addition to informing the participants of the consensus achieved, respondents were also given the option of changing their answers for the remaining statements where consensus had not been achieved during Round Four; this would in effect have constituted a non-compulsory Round Five. Panellists were given five days to respond. When no requests for a Round Five questionnaire were received, stability was declared for the remaining 11,6% of the statements.

Once more a copy of the questionnaire accompanied the feedback letter with all statements where consensus had been reached during the various rounds shaded in either *yellow* (for consensus during Round One), *green* (indicating consensus during Round Two), *blue* (representing Round Three) or *orange* (for consensus during the final round) (*cf.* Appendix A7). No individual comments were acknowledged or discussed in the correspondence.

4.2.5 Summative Discussion on the Outcome of the Delphi Survey

After Round One consensus had been reached in 38,7% (Section A 42,2% and Section B29,7%) of the statements presented in the questionnaire. After Round Two consensus had increased 65,1% in Section A and 37,2% in Section B, resulting in an average of 57,3% for the entire questionnaire. Round Three resulted in an average of 70,7% consensus for the questionnaire with 64% consensus in Section A and 73,2% consensus in Section B. After the final round, Round Four, consensus for the survey stood at 88,4% with consensus in Section A at 89,6% and section B at 85,4%. Subsequent to Round Four, stability was declared for the remaining 11,6% of the statements. Table 4.2 provides a detailed summary of the results from the various rounds.

Table 4.2 A detailed summary of the results from the various Delphi rounds [Table continues on next page].

SECTION A	ROUND 1		ROUND 2		ROUND 3		ROUND 4		STABILITY
A: Breast	18	**46**	31	**46**	35	**46**	45	**46**	1
B: Cardiac	7	**20**	12	**20**	13	**20**	16	**20**	4
C: Thoracic	18	**47**	31	**51**	32	**51**	47	**51**	4
D: Gastrointestinal	36	**76**	52	**76**	56	**76**	69	**76**	7
E: Nephro/Urological	32	**50**	38	**50**	41	**50**	45	**50**	5
F: Gynaecological	14	**33**	23	**37**	26	**37**	32	**37**	5
G: Obstetric	7	**14**	7	**14**	8	**14**	12	**14**	2

H: Neurological	24	**61**	36	**63**	42	**63**	53	**63**	10	
I: Head and Neck	15	**40**	26	**40**	30	**40**	37	**40**	3	
J: Musculoskeletal	17	**52**	33	**52**	36	**52**	40	**52**	12	
K: Paediatric	22	**48**	34	**47**	40	**47**	43	**47**	4	
L: Vascular	25	**62**	38	**62**	49	**62**	60	**62**	2	
M: Non-Radiological	20	**55**	38	**55**	41	**55**	50	**55**	5	
Consensus	255	**604**	399	**613**	449	**613**	549	**613**	64	**613**
	42,2%		65,1%		73,2%		89,6%		10,4%	
SECTION B	**ROUND 1**		**ROUND 2**		**ROUND 3**		**ROUND 4**		**STABILITY**	
A: Fluoroscopy	15	**25**	15	**25**	17	**25**	20	**25**	5	
B: Ultrasound	3	**51**	9	**54**	36	**54**	49	**54**	5	
C: CT	14	**26**	15	**26**	20	**26**	21	**26**	5	
D: MRI	29	**39**	29	**39**	36	**39**	36	**39**	3	
E: Breast	2	**22**	7	**22**	13	**22**	20	**22**	2	
F: Interventional	7	**66**	14	**66**	31	**66**	51	**66**	15	
G: Assessment	0	**7**	0	**7**	0	**7**	7	**7**	0	
Consensus	70	**236**	89	**239**	153	**239**	204	**239**	35	**239**
	29,7%		37,2%		64,0%		85,4%		14,6%	
SECTION A & B	**ROUND 1**		**ROUND 2**		**ROUND 3**		**ROUND 4**		**STABILITY**	
Consensus entire questionnaire	325	**840**	488	**852**	602	**852**	753	**852**	99	**852**
	38,7%		57,3%		70,7%		**88,4%**		**11,6%**	

4.2.6 Findings on Consensus Statements

The statements on which consensus had been reached are clearly demonstrated in Appendix A7 (grey blocks highlight which of the options on the Lickert scale attracted the consensus vote). Table 4.3 gives a detailed summary of the number of consensus statements in relation to each subdivision and according to the applicable Lickert scale. Consensus was reached on 753 out of 852 statements (549 out of 613 in Section A and 204 out of 239 in Section B). Of the 753 responses only seven agreed on option C (unnecessary) on the Lickert scale, indicating that it is not mandatory for registrars to master these skills (*cf.* Table 4.3). These statements were:

- Perform ultrasound guided parathyroid ethanol ablation (*cf.* Appendix A7 Section A: Subsection I: Statement 2:g).
- Perform the following interventional procedures (*cf.* Appendix A7 Section B: Subsection F).
    - endovascular aneurysm repair of the aorta (statement g6)
    - percutaneous nephrolithotomy (statement g14)

- RF ablation of liver lesions (statement g19)
- cerebral aneurysm coiling (statement g26)
- ultrasound guided parathyroid ethanol ablation (statement g29)
- vertebroplasty (statement g30)

Table 4.3 A detailed summary of the consensus statements at the end of the Delphi survey.

	ADVANCED	BASIC	UNNECESSARY	NUMBER OF STATEMENTS
A: Breast	23	22	0	46
B: Cardiac	5	11	0	20
C: Thoracic	30	17	0	51
D: Gastrointestinal	34	35	0	76
E: Nephro/Urological	28	17	0	50
F: Gynaecological	21	11	0	37
G: Obstetric	10	2	0	14
H: Neurological	29	24	0	63
I: Head and Neck	26	10	1	40
J: Musculoskeletal	31	9	0	52
K: Paediatric	37	6	0	47
L: Vascular	38	22	0	62
M: Non-Radiological	30	20	0	55
	FIRST HALF	**SECOND HALF**	**NOT NECESSARY**	**NUMBER OF STATEMENTS**
A: Fluoroscopy	16	4	0	25
B: Ultrasound	17	32	0	54
C: CT	14	7	0	26
D: MRI	27	9	0	39
E: Breast	3	17	0	22
F: Interventional	7	38	6	66

4.2.7 Findings Regarding Statements on Which Consensus had not been Reached

The statements on which consensus had not been reached, but which achieved stability, are clearly demonstrated in Appendix A7 (light grey blocks with the letter S highlight which of the statements on the Lickert scale attracted the most votes). Table 4.4 gives a detailed summary of the number of stability statements in relation to each subdivision and according to the applicable Lickert scale. Of the 99 out of 852 statements on which consensus had not been reached, all 99 achieved stability (64 out of 613 in Section A and 35 out of 239 in Section B). Of these 99 statements only five skills were found unnecessary (option C on the Lickert scale) (*cf.* Table 4.4). These statements were:

- Perform vertebroplasty (*cf.* Appendix A7 Section A: Subsection J: Statement 2:o)
    - *option A received 0%, option B 33% and option C 66% of the responses*
- Perform discography (*cf.* Appendix A7 Section A: Subsection J: Statement 2:p)
    - *option A received 0%, option B 44% and option C 55% of the responses*
- Knowledge of various interventional procedures (including their role, indications, contraindications and complications) (*cf.* Appendix A7 Section B: Subsection F):
    - percutaneous nephrolithotomy (statement f11)
        - *option A received 0%, option B 33% and option C 66% of the responses*
    - ultrasound guided parathyroid ethanol ablation (statement f27)
        - *option A received 0%, option B 44% and option C 55% of the responses*
- Perform the following interventional procedures (*cf.* Appendix A7 Section B: Subsection F)
    - transarterial catheter-directed chemo embolization (TACE) of hepatic tumours (statement g20)
        - *option A received 0%, option B 44% and option C 55% of the responses*

Table 4.4 A detailed summary of the stability statements at the end of the Delphi survey [Table continues on next page].

	ADVANCED	BASIC	UNNECESSARY	NUMBER OF STATEMENTS
A: Breast	0	1	0	46
B: Cardiac	1	3	0	20
C: Thoracic	2	2	0	51
D: Gastrointestinal	2	5	0	76
E: Nephro/Urological	0	5	0	50
F: Gynaecological	0	5	0	37
G: Obstetric	1	1	0	14
H: Neurological	7	3	0	63
I: Head and Neck	1	2	0	40
J: Musculoskeletal	6	4	2	52

K: Paediatric	0	4	0	47
L: Vascular	1	1	0	62
M: Non-Radiological	5	0	0	55
	FIRST HALF	**SECOND HALF**	**NOT NECESSARY**	**NUMBER OF STATEMENTS**
A: Fluoroscopy	2	3	0	25
B: Ultrasound	0	5	0	54
C: CT	1	4	0	26
D: MRI	0	3	0	39
E: Breast	1	1	0	22
F: Interventional	2	10	3	66

4.3 SUMMATIVE DISCUSSION

This chapter comprises the results of the Delphi survey and an exposition of the findings from the data. The Delphi survey was conducted over four rounds and at the conclusion of the survey, consensus had been reached on 753 out of 852 (88,4%) statements and there was stability regarding the remaining 99 (11,4%) statements.

In Section A consensus was reached on Option A (which stipulated that by the end of the registrar training period, a candidate should have mastered this skill at an advanced level) in 342 of the statements, whilst 80% or more of the respondents agreed on Option B (which stipulated that by the end of the registrar training period a candidate should have mastered this skill at a basic level) in 206 of the statements. Only one statement had agreement for Option C (which indicated that it is not necessary for the registrar to acquire this skill).

In section B, consensus was reached on Option A (which stipulated that a registrar should achieve/master this skill during the first half of the training period and which implies that his or her competence in this skill will be examined during or by the end of the first half of the training period) in 84 of the statements whilst Option B (which stipulated that a registrar should achieve/ master this skill during the latter half of the training period and which implies that his or her competence in this skill will be examined during or by the end of the latter half of the training period) attracted 80% or more of the responses in 107 of the statements. Option C (which indicated that it is not necessary for the registrar to acquire this skill) was agreed upon in only six of the statements. In Section B, subsection G – which dealt with the assessment schedule –

consensus was reached on Option A (which stipulated that during his/her postgraduate training a registrar should undergo an assessment after each rotation) for all seven statements.

4.4 INTERPRETIVE DISCUSSION

An informed and critical analysis of the Delphi survey results revealed the following:

Intrinsic to its content and structure, the survey defined a broad basic knowledge that covers a large spectrum of diagnostic radiological imaging and diagnostic radiological procedures, as well as their use in the diagnosis and treatment of medical and surgical disease. This highlights the sentiment of several Delphi panellists who felt that in South Africa we should be training general radiologists. This in turn echoes the researcher's own perception that South Africa is not yet in a position to include routine sub-specialty training as part of the postgraduate radiology curriculum (take for example the ABR radiodiagnosis curriculum).

The survey furthermore identified a core of advanced knowledge, suggesting a more basic knowledge in terms of certain MR imaging studies (cardiac MRI, breast MRI, MR enterography and enteroclysis, prostate MRI, MR defecography, MR diffusion imaging, MR brain functional imaging, MR sialography and dacrocystography), CT imaging studies (cardiac CT, CT colonography, DECT applications, CT brain perfusion), diagnostic ultrasound (endovaginal ultrasound, ultrasound of all large joints except the shoulder) and diagnostic fluoroscopic procedures (defecography, dacrocystography, ductography). This prescribed knowledge encapsulates knowledge about the use of the imaging study, technical aspects about the imaging study and reporting the acquired diagnostic images. Many of the mentioned diagnostic investigations can be seen as a group of more specialised investigations perhaps not yet commonplace in all academic radiology departments because more trusted alternatives are still available (e.g. cardiac CTA vs. catheter coronary angiography, CT colonography vs. CT colonoscopy, MR defecography vs. conventional defecography). Other investigations, such as endovaginal ultrasounds, are (in the experience of the researcher) generally performed by gynaecologists.

Registrars are expected to acquire a more general knowledge about the role of interventional radiology, both as a diagnostic and as a therapeutic tool. The survey identified a handful of interventional procedures in which the registrar is expected to attain a level of skill that allows the registrar to independently perform a procedure safely and competently, without supervision (these include ultrasound-guided FNA of various organs, imaging-guided aspiration of pleural and peritoneal fluid, imaging-guided drainage of intraperitoneal fluid collections and abscesses, as well as all diagnostic angiographic procedures). As for the rest, registrars are required to have a basic knowledge (occasionally advanced) about the indications, contraindications and complications, as well as a basic proficiency in performing most interventional procedures (with the exclusion of parathyroid ethanol ablation, endovascular aneurysm repair of the aorta, percutaneous nephrolithotomy, RF ablation of liver lesions, trans-arterial catheter-directed chemo embolisation of hepatic tumours, cerebral aneurysm coiling and vertebroplasty). These findings effectively side-line interventional radiology as a sub-specialty in the context of South African radiology. Working in a radiology department with a fully operational interventional radiology unit (which also offers the only postgraduate interventional radiology training fellowship in South Africa) it was important for the researcher to establish the level and scope of interventional radiology training suitable to postgraduate radiology education in South Africa.

The survey prescribes an advanced level of knowledge and skill (complete proficiency) in performing transabdominal ultrasounds for the confirmation of pregnancy and first trimester transabdominal ultrasound only (not for endovaginal ultrasound nor second or third trimester obstetric ultrasounds).

The survey results advocate the inclusion of non-radiological skills in the radiology syllabus (*cf.* Section One Subsection M of the questionnaire). The challenge lies in addressing these topics, determining the best method and correct level of exposure (of registrars to the individual topics) and, where necessary, assessing the attainment of adequate competence regarding the individual topics.

Nuclear imaging remains an integral part of diagnostic radiology and the survey recommends a basic level of knowledge about the role of individual nuclear studies as an adjunct to diagnostic imaging for certain diseases. It also advocates a basic level of proficiency in interpreting various routinely performed nuclear studies. This infers suitable exposure to nuclear imaging during a registrars training period. The survey, however, did not address the most suitable method of said exposure to nuclear imaging.

4.5 CONCLUSION

The Delphi questionnaire survey was used to collect opinions from a group of experts regarding the content of a South African postgraduate radiology curriculum.

Section A of the Delphi questionnaire set out to determine which knowledge (including radiological anatomy, pathology, imaging instrumentation and physics, modality-based expertise in imaging applications and image quality and system-based expertise in regional and organ-based diagnosis) and which procedural skills (such as region, organ, and modality-specific skills, image-guided injections, biopsy and drainage of hollow organs or collections, fluoroscopic procedures, performance of ultrasound studies and arteriographic and venographic procedures) should ideally be included in the curriculum. None of the knowledge-related statements were deemed unnecessary, whilst only one of the procedure-related statements was excluded. Although it can be argued that the questionnaire was not comprehensive there were no additions suggested by, and very few comments from, the respondents throughout the entire survey. This could be seen as an indication of the respondents' satisfaction with the content of the questionnaire or it stemmed from a degree of apathy – the questionnaire was unfortunately quite lengthy – but then again, it was based on present-day postgraduate curricula from around the world.

Section B of the questionnaire focused more on procedural knowledge and skills: it set out to determine which of these competencies were necessary and during which half (junior or senior) of the training programme registrars could be expected to acquire these competencies. Besides informing the content of the curriculum, this information was also used in the design of the assessment programme. At the conclusion of the questionnaire there were only six exclusions – all six statements involved interventional radiology procedures.

The combination of Sections A and B informed the content of the curriculum – it facilitated the compartmentalisation of skills and knowledge according to levels of training and experience and according to depth of knowledge and level of proficiency.

The high degree of consensus and stability and the high response rate in the survey all support the usefulness of conclusions drawn from the data.

In the next chapter, Chapter 4, entitled **Discussion of the Findings: Semi-Structured Interviews**, the findings of the semi-structured interviews will be discussed.

CHAPTER 5

DISCUSSION OF THE FINDINGS: SEMI-STRUCTURED INTERVIEWS

5.1 INTRODUCTION

This chapter presents the findings of the semi-structured interviews that were conducted as part of the doctoral research. The semi-structured interviews focused on the continuous in-training assessment of registrars enrolled in postgraduate radiology training in South Africa and specifically the implementation of a formal, structured continuous assessment programme consisting of a range of standardised assessment tools (instruments), applied according to a predetermined timeline which spans the duration of their studies. The interviews were conducted with individuals identified as key role-players in postgraduate radiology training in South Africa (*cf.* 3.2.3.6).

5.2 DATA ANALYSIS OF THE SEMI-STUCTURED INTERVIEWS

The process of data gathering is described in Chapter 3 (*cf.* 3.2.3.7) and can be summarised as follows:

All interviews were conducted in person and by the researcher. An interview guide (*cf.* Appendix B3) ensured that the structure of the interviews remained consistent, and that all relevant topics were addressed during the various interviews. All interviews were recorded (with the written consent of the interviewee) for transcription and reference purposes. This made possible the consequent review and detailed analysis of all interviews and also ensured an accurate copy of all the interviews for later reference. The researcher made field notes during and after the interviews, which were used extensively during the subsequent qualitative analysis of the interviews.

The data was analysed by the researcher according to qualitative data analysis methods. The process of analysis involved coding, categorising and the identification of themes within the data collected – all the while staying rooted in and connected to the initial interview questions. Similar codes (concepts) were grouped and regrouped, reducing the variety of responses and simplifying the reporting process. Care was taken not to change the meaning and context of the responses. Phrases were linguistically adjusted or abbreviated to simplify the reporting of the findings. The themes, categories and codes, as identified by the researcher, were then revised by one of the promoters. After completion of the analytical process the collected data was refined into usable information that informed the continuous assessment programme framework.

The consistent method of the interviewing process, the use of the same interview guide for each and every interview, and the researcher conducting every interview in person, contributed to the reliability of the semi-structures interviews. Transcriptions of the audio recordings (of the interviews) were verified by the researcher and an independent person – this ensured the reliability of the collected data.

The different interviews were assigned different colours (and numbers according to the order in which the interviews were conducted) – the comments (codes) from the different interviewees were consequently printed in the colour corresponding to the interview. The first interview's codes are in **grey**, the second in **red**, the third in **blue**, the fourth in **purple**, the fifth in **green** and the last in **orange**. Where a specific code (comment) came up in more than one interview, it is indicated by the number(s) corresponding to the interview(s), typed just after the original code. The same number and colour was used for the same interviewee throughout the analysis and reporting of the data. This enables the reader to not only compare the responses of various interviewees, but also the different responses from the same interviewee. The inclusion of direct quotes of some of the responses from the interviewees (indicated by text in quotation marks) enhances the trustworthiness of the study.

5.3 THE RESULTS, DATA ANALYSIS, DESCRIPTION AND DISCUSSION OF THE FINDINGS OF THE SEMI-STRUCTURED INTERVIEWS

In order to simplify the analysis process, each question of the semi-structured interview guide will be analysed and discussed separately.

5.3.1 Assessment Tools to be Included in a Formal and Structured Continuous Assessment Programme for Postgraduate Radiology Training in the South African Context

As mentioned earlier, all participants received a copy of the interview guide (*cf.* Appendix B3) at least one week prior to the interview. This was done to allow the interviewee time to process the questions and formulate their thoughts and opinions prior to the actual interview. In addition to the interview guide, each participant also received an information document (Appendix B4). This document, complied by the researcher, provided information on the different workplace-based assessment methods used by postgraduate radiology training programmes in Australia, New Zealand, America, the United Kingdom, and the Netherlands. The document provided a short explanatory description of each assessment method, as well as reflects on the use of these assessment methods in the assessment of the different CanMEDS roles as they apply to radiology.

The opening question, ***Which assessment tools, in your opinion, should be included in a formal and structured continuous assessment programme for postgraduate radiology training in South Africa?*,** although informed by the information document, was not limited to the methods discussed in the information document, but was open to other assessment methods brought to the discussion by the interviewee.

The question was posed to all interviewees and all the answers that were given were coded. The codes were subsequently arranged into categories (where possible), and the categories in turn grouped into themes.

The themes that emerged from the answers to the question were:

- Mini-Imaging Interpretation Exercise (Mini-IPX)
- Radiological Direct Observation of Procedural Skills (Rad-DOPS)
- Multisource Feedback (MSF)
- Teaching Observations
- Critically Appraised Topics (CAT)
- Audit Assessment
- Multidisciplinary Teamwork
- Review of dictation.

Each theme, with their respective categories and codes, are summarised in Table 5.1 and subsequently discussed individually. Direct quotes by the interviewees are included in order to enhance the trustworthiness of the study. Where the interview was conducted in a language other than English, the researcher took the liberty of translating direct quotes into English, taking care not to deviate from the perceived meaning of the original response.

Table 5.1 Assessment tools to be included in a formal and structured continuous assessment programme for postgraduate radiology training the South African context [Table continues on next pages].

THEMES	CATEGORIES AND CODES
Mini-Imaging Interpretation Exercise (Mini-IPX)	Adds value to a formal and structured assessment programme • important assessment tool – assesses a core competency central to radiology, whilst candidate undertakes the activity • valuable assessment tool [5] • ideal assessment tool in judging depth of knowledge and approach to diagnostic problems • useful • have merit • should be included in a formal assessment programme • can be used both formally or informally • mostly used informally (at this institution) but can be formalised with little effort • helpful in "moving them [registrars] out of their comfort zone" • done frequently and routinely [at this institution] – tutorials and mock exams • do some formally depending on the rotation [at this institution] • ideally suited to radiology tutorial sessions (more formal assessment) • "formal assessments necessary to document progress" Valuable – can be used informally • can be used both formally or informally [6] • "used informally to conduct CT assessments" • should be used informally during day-to-day activities – i.e. continuous and frequent The role of Mini-IPX in the assessment of a registrar • "gives a good account of candidate's imaging interpretation skills and ability to reason critically, and thereby reaching a logical conclusion" • assesses "growth of knowledge and interpretation skills" [6] • allows comparison with peers who have similar level of experience • assesses candidate's "line of thinking" – in other words, the level of knowledge and approach to a diagnostic challenge • identify gaps in knowledge and experience • determines whether a registrar is safe • can help to motivate studies

	Feedback • the way it is presently used (at this institution) it does not always result in feedback • should ideally include feedback Remedial action • the way it is presently used (at this institution) it does not lead to formal and frequent remedial action [2], [3], [5] • "continued tutorials would be the simple answer"
Radiological Direct Observation of Procedural Skills (Rad-DOPS)	Adds value to a formal and structured assessment programme • "incredibly important" [3] • have merit • are valuable • very handy • complements mini-IPX • essential in the assessment of ultrasound, fluoroscopy and interventional rotations • can be used formally or informally • employed as a formal assessment once after an initial rotation (at this institution) • formalised evaluation at the end of each monthly rotation (at this institution) which leads to feedback and remedial action • sees value in formalising the assessment • better suited to ultrasound rotation • occasionally done formally depending on rotation [at this institution] • can stipulate minimum number of formal assessments per year but value lies in frequent informal assessment during day-to-day activities • "formal assessments necessary to document progress" • "some things have to be (more) formally assessed" Valuable – can be used informally • can (should) be used formally or informally [6] • mostly used informally at this institution [2] • easier to assess informally and continually during rotation • informally during daily observation and interaction • better suited to fluoroscopy rotation • should be integrated into day-to-day activities and not require additional time The role of Rad-DOPS in the assessment of a registrar • vitally important in the evaluation of procedural and practical skills • assesses a wide range of competencies – "represents the complete package" • assesses not only knowledge but also "soft skills" • "judge them on their interaction with the patients, their personality, their maturity, their approach to procedure" • used in preparation for the final examinations

	• ideal for judging levels of competence – practical, foundational and reflective competence (see discussion for definitions of the different levels) • "is the candidate safe?" Feedback • it is important to give feedback • the way it is presently used (at this institution) it does not always result in feedback • "we give them feedback at the end of the month [following monthly assessment]" Remedial action • the way it is presently used (at this institution) it does not lead to formal and frequent remedial action [2], [3], [5] • generally not possible due to staffing issues (not enough consultants to cover all the stations) • routinely employed at this institution – candidates get mentored through identified problems or re-allocated to problem areas Other • sees value in a predetermined set of core procedures/ skills to be assessed in determining a registrar's general competence • not in favour of giving a candidate carte blanche to decide which or when assessments should take place • concerned about candidates apprehension and nervousness during a formal assessment • staffing dependent – not always enough consultants to oversee all the stations e.g. screening and IR theatre • should formally assess certain absolute minimums (not necessarily modality or organ dependant) – these have to be identified beforehand
Multisource Feedback (MSF)	Valuable – can be used informally • "there is great value in it" • has value and merit • "very important" • reservations about the value and impact of MSF as a formal assessment • likely to provide a general impression • MSF assessment not essential (understood to mean formal) • should not be included as a formal assessment • "probably has its advantages" • should be used formatively • done informally [at this institution] – not using a tick sheet but via regular meetings with all aspects of the department • confidentiality is paramount • information and opinions collected should not be included in a portfolio

	The role of MSF in the assessment of a registrar • addresses a neglected set of generic skills/attitudes such as communication and interaction with colleagues and patients • "more of a personality assessment" • valuable in assessing human interaction [2] • can identify problems with attitudes [3] • assesses CanMEDS roles – manager, collaborator • important part of developing an all-round (complete) physician Feedback • value of assessment dependent on feedback • assessment has to lead to feedback • problems are discussed with the individual registrar or across the board with all registrars depending on severity of problem • results can be discussed during yearly contact session with Head of Department or programme director Other • assess behaviour often embedded in human nature or personality traits – how do we address and remedy failures and shortcomings? • problem lies in how to effectively deal with the identified weaknesses or problems • once during training period is sufficient • clinicians probably the key respondents • do not have to be performed formally in order to identify problems
Teaching Observations	Adds value to a formal and structured assessment programme • "probably a good idea" • "good idea to mark them on it" • not a criterion for the exam and thus not formally marked – used formatively (candidate gets guided) • handy but not as important as mini-IPX and Rad-DOPS • should be easy to implement • to be used formally • assessed using a standardised tick-sheet • suggests one or two assessments per year • can be used informally and formatively • happens informally during the various departmental meetings (? scored) • assessment and improvement of communication and presentation skills important for the exams • feedback is important (perhaps more important than formalising the actual assessment) • any contact sessions where teaching takes place can be observed and used to assess candidate • more informal assessment – give feedback • "to teach is to know"

	The role of TOs in the assessment of a registrar • not sure about the role of TOs • the ability to teach is not a main priority in radiology • "assesses speaking skills" – communicator [4] • teaching assessment can assess a candidate's communication skills and knowledge [5] – helps to identify the weaker candidate who needs help [6] • "they have to know how to present because they are going to present in the exam" • can also judge level of competence – the application of knowledge and experience to solve problems
Critically Appraised Topics (CAT)	Does not add value to a formal and structured assessment programme • problematic • sees value in acquiring the skill (critical appraisal of articles and research) but not convinced it should be assessed [3] • important skill to have – especially as research is becoming part and parcel of radiology • critical thinking is integral to research and thus developed during completion of research product – successful completion of the research project suggests adequate exposure and mastery of this skill [5] • any formally assessment of CATs should not contribute heavily to overall evaluation of a candidate's competence • concerned that very few (if any) have the skill or expertise to act as CAT assessor • good idea • do not formally assess at this point [at this institution]
Audit Assessment	Does not add value to a formal and structured assessment programme • "more focused on service delivery" • not necessarily included in a formal assessment programme • not entirely sure how this would benefit a registrar • "do not see the value"
Multidisciplinary Teamwork	• not formally assessed • should be useful if formalised • useful in identifying the weaker candidate – gives a good reflection of a candidate's performance
Review of Dictation	Adds value to a formal and structured assessment programme • self-assessment (audit) of prior year's reports • "review and critically evaluate 10 of your reports from the previous year" • critique style and content of reporting • once a year • in collaboration with programme director • "we are neglecting our reports" • purely formative Valuable – can be used informally • done daily at the workface or morning rounds (at this

	institution) • performed informally and subjectively • could assess formally during more senior years
Double reading	• done routinely morning after night call
Other	Assessment • "a predefined period of time on a recurring basis where everyone is alerted to the fact that it's a testing session" is probably the least disruptive in terms of activity and will give the truest reflection – thus considered the most valuable option • evaluations at the end of the month is based on cumulative day-to-day performance throughput the month [at this institution] – does not score a mark but simply satisfactory or unsatisfactory, with comments about performance e-Resources such as Rad Primer • used similarly to Mini-IPX • "assign specific modules as assignments to [the registrars]" • can monitor what each registrar has done Consensus opinions from consultant meetings • feedback problematic • suggest Head of Department plus mentoring consultant • written summary with overall assessment according to categories and not marks

5.3.1.1 *Mini-Imaging Interpretation Exercise (Mini-IPX)*

Mini-IPX is an assessment tool designed to assess the proficiency of a registrar in interpreting diagnostic medical images. The assessment involves a single patient and may be confined to a single imaging examination or extend across a series of imaging studies that culminate in a specific diagnosis. Assessment takes place within the normal working environment, where the assessor directly observes the registrar interpreting the images. The candidate verbally reports all the relevant findings and diagnosis, and answers all related questions. The performance of the registrar is scored on the scale shown on the Mini-IPX assessment form and judged according to the registrar's level of training and experience (for an example of such an assessment form *cf.* Appendix C1). Immediately following the assessment, the assessor provides formative and constructive feedback about the candidate's performance – especially where inadequacies have been identified. During informal assessment of interpretive skills, no arrangements are made for the observation and the assessment is not recorded on a standardised Mini-IPX assessment form.

The interviews revealed that an assessment of interpretation skills is frequently performed at most of the departments where interviews took place. This type of assessment is generally integrated into the day-to-day activities of the registrars, where it takes place informally and does not lead to any formal grading or the documentation of an individual performance. The assessment also seldom leads to formal feedback or remediation when inadequacies are identified.

All interviewees saw the Mini-IPX as an important and valuable assessment tool, which examines the knowledge and thought processes of a registrar, engaged in activities at the core of diagnostic radiology. Interviewees felt that it gave a good account of a candidate's imaging interpretation skills and ability to reason critically, that it identifies gaps in knowledge and experience, motivate further studies, allows comparison with peers who have a similar level of experience and has the ability to plot the development (or lack thereof) of competence.

There was support for both formal and informal use of the assessment tool; suggesting that it be used (informally) frequently and continuously in order to timeously identify inadequacies and aid further learning, whilst at the same time recognising the need to formally document assessment of performances every now and then. A general consensus, therefore, that this method of assessment should be included in a radiology postgraduate assessment programme.

From the interviews it would also seem that formal feedback is the exception rather than the rule. All interviewees were nonetheless in favour of assessment resulting in feedback, whether the assessment is formal (documented) or informal (as part of routine activities at the workface). Feedback should be constructive and where inadequacies are identified, measures should be suggested to improve those inadequacies. There was a lack of clarity about how to remedy identified inadequacies, but interviewees generally felt that whereas the assessor could inform (even guide) such remedial action, it was up to the registrar to put in the hard work.

5.3.1.2 *Radiological Direct Observation of Procedural Skills (Rad-DOPS)*

Rad-DOPS involves the direct observation of a registrar undertaking a clinical practical radiological procedure (for example an abdominal ultrasound, FNA of a thyroid nodule, barium enema etc.). This assessment is designed to assess all the skills needed to perform such a procedure accurately, safely and independently. A qualified radiology consultant, with the necessary expertise to assess the specific procedure, usually accounts for the assessment. The performance is judged according to the registrar's level of training and expertise and scored according to a standardised rating scale on the Rad-DOPS assessment form (for an example of such an assessment form *cf.* Appendix C2). Upon completion of the assessment the assessor provides the candidate with constructive feedback about his or her performance. Where inadequacies are identified, steps should be taken to remedy the situation. During informal assessment of procedural skills, no arrangements are made for the observation and the assessment is not recorded on a standardised Rad-DOPS assessment form.

As with the Mini-IPX, all interviewees identified Rad-DOPS as something similar to what they have been doing in their respective departments – often as a formal assessment at the end of a rotation but mostly informally and continuously during the rotation. Whilst all viewed this method of assessment as valuable, some went as far as referring to Rad-DOPS as incredibly important and essential to the assessment of ultrasound, fluoroscopy and interventional rotations. Interviewees felt that this particular form of assessment assessed a wide range of competencies – that it represents the complete package – assessing not only knowledge and procedural skills, but also soft skills such as the registrar's interaction with the patients, their personality, their maturity and their approach to the procedure. One of the interviewees considered Rad-DOPS (together with Mini-IPX) as ideal for judging the levels of competence – practical, foundational and reflective (for definitions of these terms *cf.* Table 5.2).

Table 5.2 Definitions of practical, foundational and reflexive competence (taken from SAQA Policy document on Criteria and Guidelines for Assessment of NQF Registered Unit standards and Qualifications 2001:11).

<table>
<tr><td>PRACTICAL COMPETENCE</td><td>The demonstrated ability to perform a set of tasks and actions in authentic contexts (situations)</td><td rowspan="3">All three combined constitute Applied Competence</td></tr>
<tr><td>FOUNDATIONAL COMPETENCE</td><td>The demonstrated understanding of what we are doing and why we are doing it</td></tr>
<tr><td>REFLEXIVE COMPETENCE</td><td>The demonstrated ability to integrate our performances with our understanding so that we are able to adapt to changed circumstances and explain the reason behind these adaptations</td></tr>
</table>

Some interviewees were comfortable with the formal use of Rad-DOPS, whereas others preferred implementing it in its informal capacity, integrated into the day-to-day activities and not requiring any additional time. The researcher though felt that there was scope for both (this will be discussed in more detail in Chapter 6).

Whether used formally or informally, the consensus was that feedback would benefit the candidate and that an effort had to be made to standardise this activity. Remedial action, again, represented the exception to the rule and despite many thinking this a good idea, enthusiasm was curtailed by apparent staffing issues.

A suggestion to formally assess a predetermined set of core procedures or skills were further refined into the need to formally assess certain absolute minimum skills – not necessarily organ or modality dependent but rather critical cross-field abilities such as being able to perform an ultrasound-guided fine needle aspiration or the Seldinger technique.

5.3.1.3 *Multisource Feedback (MSF)*

MSF relies on the opinions of various people who have reasonably regular and direct work-related interaction with the registrar being assessed. MSF is designed to assess generic skills such as communication, teamwork, reliability, leadership, professionalism etc., thus providing an overview of the registrar's clinical performance and professional behaviour within the workplace. Assessors from the following four groups of co-workers – other senior clinicians, allied health professionals, administrative or clerical staff and other registrars – unanimously complete questionnaires on which they judge the candidate's performance in areas of teamwork, professionalism, communication skills and management/ administrative skills. In addition, the registrar is required to complete a self-assessment using the same questionnaire and rating scale.

Interviewees recognised that this method of assessment addresses a neglected set of generic skills/attitudes such as communication and interaction with colleagues and patients and CanMEDS roles such as manager and collaborator; competencies essential to the development of a complete physician.

Comments about Multisource Feedback were varied and ranged from "probably has its advantages" to "has value and merit" and "very important". There was considerably more uniformity of opinion with regard to the formative use of MSF and the reluctance to include it as part of the formal assessments. From the interviews the researcher concluded that MSF was not an assessment that lent itself to grading, but rather depended on feedback for its value and merit. The value of MSF therefore lies in its ability to identify problems related to a registrar's professional behaviour and clinical performance. Addressing these inadequacies (often embedded in human nature or locked up in personality traits) may however prove problematic; as evidenced during the interviews where solutions to these problems were not forthcoming.

5.3.1.4 *Teaching Observations*

Teaching Observation judges a registrar's ability to teach, based on any teaching done by the registrar. An assessor directly observes the registrar teaching and scores the performance using the standardised rating scale on the assessment form. Structured and formative feedback, during which time the assessor reflects on the candidate's competence to teach, should follow immediately after the assessment.

Opinions were divided as to whether the assessment should be formal or informal – the main difference being that the former is documented and scored on a standardised assessment form; one interviewee noted that teaching is not a criterion for the examination and is therefore not required to be marked formally whereas another remarked that the ability to teach is not a priority in radiology. Other comments focused on the fact that communication and presentation skills are important for the final examinations – "they have to know how to present because they are going to present in the exam". Another interviewee reflected on the fact that TO may help identify the weaker candidate, as the teaching performance reflects a registrar's knowledge and communication skills (which is generally better in the more accomplished candidate).

From the interviews the researcher concluded that Teaching Observation as a radiology assessment method has value and merit, if only for the fact that it assesses communication skills, which is one of the CanMEDS core competencies. In addition to communication, TO also assesses the candidate's knowledge of the subject being taught. Whether performed formally or informally, the value of the assessment ultimately lies in the feedback to the registrar, which should be aimed at improving his or her communication skills and subject knowledge.

5.3.1.5 *Critically Appraised Topics (CAT)*

In the context of postgraduate radiology assessment, a CAT is a structured one-page review and critique of an image-related peer-reviewed research publication, following critical analysis of the research article. Assessment usually takes place during the registrar's presentation of the CAT.

> *"Critical appraisal is the process of carefully and systematically examining research to judge its trustworthiness, and its value and relevance in a particular context"* (Burls 2009:2).

Across the board, everyone acknowledged the importance of critical appraisal in evidence-based medicine and sees the value in acquiring the skill of critical appraisal. There was, however, no support for the formal assessment of this skill. One of the interviewees argued that critical thinking and appraisal is integral to (conducting) research and that the skill is thus developed during completion of the research component (registrar are required to complete an original research component as part of their postgraduate radiology training); there is therefore no need to formally and separately assess this skill.

5.3.1.6 *Audit Assessment*

A clinical audit involves the formal review of systems, pathways and outcome of care, comparing these against predefined standards and identifying reasons behind standards not being achieved. An audit may also include a review following the implementation of changes.

Collectively, the interviewed group did not see the value of, or the need for, this method of assessment.

5.3.1.7 *Multidisciplinary Teamwork (MDT)*

This assessment method is designed to assess the performance of the registrar as part of a multidisciplinary team during multidisciplinary meetings. An assessor directly observes the registrar's contribution and ability to assume a leadership role during a routine, scheduled, multidisciplinary meeting. The performance is documented on a

MDT assessment form and scored using a standardised rating scale. Immediately following the meeting, the registrar is provided with formative and constructive feedback.

Not many interviewees commented on this assessment. As with TO, one interviewee saw the value of such an assessment in identifying the weaker candidates; Multidisciplinary Teamwork requires communication and presentation skills combined with the application and understanding of subject knowledge.

A counter argument to the separate and formal assessment of MDT skills holds that these skills can be assessed (informally) during the registrar's performance of day-to-day activities (which include several interactions with clinicians).

The researcher's concern with the latter is that these informal assessments do not result in feedback and therefore adds very little in the way of improving the candidate. Interactions with clinicians and working as part of a multidisciplinary team is central to radiology and in the mind of the researcher; this assessment may be worth the effort.

5.3.1.8 *Review of Dictation*

Review of registrars' reports is commonplace at all the academic radiology departments where interviews were conducted. The reviews and subsequent feedback are generally not aimed at assessment but rather ensuring that reports are accurate before being sent to the referring physician. Double reading the morning after an after-hours call falls into the same category.

In the researcher's own experience registrars are very seldom, if ever, taught how to construct a meaningful and accurate radiology report – as one of the interviewees agree, "we are neglecting our reports". This, in the opinion of the researcher, is an important oversight, as reports are usually the sole conveyer of the findings of the radiological procedure or investigation and the radiologist's opinion regarding these findings. In this capacity it also represents a major medico-legal document. The same interviewee (quoted above) suggests a self-assessment whereby the registrar critically reviews a certain amount of his or her reports from the previous year. This can also serve a formative function when combined with the feedback from a programme director or a qualified radiology consultant. Such an assessment could be aimed at the style, content and correctness of a report and should cover all the various modalities.

5.3.2 The Formative and Summative Functions of Continuous In-training Assessments

The second question posed to all interviewees was: ***In your opinion, should the assessment tools be used formatively (i.e. to inform future learning) or should it be used summatively (whereby failure to attain a satisfactory assessment can prevent a candidate from advancing)?***

The answers were coded and divided into categories (*cf.* Table 5.3).

Table 5.3 The formative or summative function of continuous in-training assessments [Table continues on next page].

THEMES	CATEGORIES AND CODES
Formative assessment	Gives an indication of performance • continuous assessment should contribute to the candidate's insight into his own performance • feedback is therefore vital • assessment should categorise a performance rather than assigning a percentage or an absolute score [4] • assessments like Rad-DOPS and Mini-IPX should be used formatively Feedback • "feedback is essential" • should be immediate • "one positive benefit of feedback is to alert people who may not have self insight into their relative performance and who respond favourably to that" • a bigger concern are those who are aware of the fact that they are not doing well and do not respond – how to address them ? • positive feedback to build morale and self-esteem • feedback re-assures candidate • feedback motivate continuous performance and learning Remedial action • remedial action should be initiated in those candidates whose performance is deemed unsatisfactory • remedial action can be (too) labour intensive • not the responsibility of the consultant to see to it that a

	candidate improve – consultant can guide and suggest • responsibility lies with the registrar to effect the improvement • sit-down sessions, dummy cases, interactive quizzing • not everyone will respond/ improve • may isolate/ socially negatively impact problematic candidates • not enough staff to attend to double learning • "these problems do not obviate the need for accurate assessments" Applies to both formal and informal assessment • "ideal function of in-training assessments" • "assessment becomes active training opportunity" • formal in-training assessment consist of assessment, judgement (rating according to a predetermined scale), feedback • unsatisfactory performances should be reassessed after a period of time • informal in-training assessments consist of assessments performed at the workface with suggestions of how to improve on deficient aspects of performance • formative assessment should be integrated into daily activities – should be continuous Other • registrar's performance should be judged against the performance expected for the candidates level of training • "should be able to plot a candidate's performance on a curve" – i.e., they are expected to improve • assessment, despite being formative, should include a grading such as satisfactory and unsatisfactory, which needs to be documented • some assessments lend themselves really well to a purely formative function such as MSF and MDT • logbooks do not form part of formative assessment
Summative assessment	Other • formative assessment is better • not really beneficial in continuous assessment • results can be used summatively to prevent progression of a candidate • none of the continuous assessments [at this institution] receive a mark but rather a comment • a progress test [such as in the Netherlands] is marked for the purpose of reflection/comparison and to indicate progress • mock exams are marked

5.3.2.1 *Formative Assessment*

Formative assessment comprises the actual assessment, the immediate and constructive feedback and subsequent remediation – where applicable (*cf.* p61-62).

Assessment of a registrar's performance gives an indication of that individual's knowledge, skills and professional behaviour. The performance is judged against a standard relevant for the candidate's level of training and experience. The assessment provides information to both the assessor and the candidate being assessed. Both individuals should use the information to improve the performance of the registrar where possible and necessary. For this reason, "feedback is essential".

According to one interviewee, continuous formative assessment should contribute to a registrar's insight into his or her own performance. Several interviewees also felt that formative assessments should categorise a performance (for example satisfactory or unsatisfactory) rather than assign a percentage or an absolute score. Rad-DOPS and Mini-IPX were highlighted as being ideally suited to formative assessment.

All interviewees felt that feedback was important and some commented that it was provided informally on a daily basis. As this study focuses more on formal assessments and the associated feedback (in the event of formative assessment), a few interviewees expressed concern about the (cumulative) time needed to provide feedback after each assessment. The researcher feels that this concern is influenced by each department's structures, systems and pathways and the buy in from the respective heads of departments, but if planned and managed correctly, should not stand in the way of formal formative assessments. One of the interviews elicited discussion about the registrars' response to feedback – "one positive benefit of feedback is to alert people who may not have self insight into their relative performance and who respond favourably to that", whilst there is concern about those who are aware of, or have been alerted to, the fact that they are not doing well and do not respond – how to address them? As for those who are receptive, constructive feedback can re-assure a candidate, motivate continuous performance and learning and build morale and self-esteem according to one interviewee.

Remedial action builds on feedback and addresses issues identified during the assessment. Whilst all interviewees recognised the importance and benefits of remedial action there were concerns about staffing and time issues. The same interviewee had concerns about the possible socially negative impact remedial action may have on problematic candidates, but was quick to add that "these problems do not obviate the need for accurate assessments". Another suggested that remedial action be reserved for those cases where a candidate's performance is deemed unsatisfactory. From the interviews one thing is clear, remedial action should not be labour intensive and, although consultants can guide and suggest, the responsibility lies with the registrar to effect the improvement.

Further views hold that formative assessment can either be formal or informal; in-training assessments should ideally be formative; formative assessments should be continuous and as such integrated into daily activities; formative assessments, conducted correctly, becomes part of training; and formal formative assessments have to include a grading such as satisfactory and unsatisfactory, which needs to be documented.

5.3.2.2 *Summative Assessment*

There was no support, amongst the interviewees, for purely summative assessments as part of continuous workplace-based assessments. Summative assessments were reserved for quarterly image-based assessments (these marks made up the year mark) and mock examinations.

5.3.3 Who Should be Involved in the Assessment of Registrars?

Question three asked the interviewees' opinion on who they thought should be involved in the in-training assessment of the registrars: ***In your opinion, who should be involved in the assessment of registrars?***

The answers were coded and divided into categories (*cf.* Table 5.4).

Table 5.4 Who should be involved in the assessment of registrars? [Table continues on next page].

THEMES	CATEGORIES AND CODES
Qualified radiologists	Consultant radiologists from the same department • "obvious choice" [3], [6] • best qualified to assess imaging interpretation and procedural or practical skills [4] • can also conduct TO • "potential for personal bias" Consultant radiologists from other departments • not practical [6] • not really • can be used in mock exams to determine exam readiness • reliability, validity and fairness concerns Private radiologists • maybe – may work with IPX and DOPS • could be used in mock exams to determine exam readiness [4] • too complicated • possible but problematic • different spectrum of activities and different set of priorities [6] • time constraints • they will initially not be accustomed to the situation • probably well-suited to evaluating plain x-ray reporting skills • those with fellowships may assess above the level expected of a general radiologist/ registrar [2] • can assess a candidate during a tutorial session – "very nice objective opinions" – mostly limited to IPX [5]
Non-Radiologists	Consultant from other disciplines/ medical specialities • may judge something other than the technical skills inherent in radiology • could probably assess certain and specific skills related to assessor's speciality – should be linked to a specific case but not in a position to give a global assessment • not officially • assessment of a rotation through orthopaedics or nuclear medicine but not part of radiology departmental internal assessment • yes – but limited to imaging, could improve collaborator and communicator skills Sonographers • well suited and skilled enough to do ultrasound assessments

	• definite option - "very critical of registrars" • depends on quality of sonographer • yes – expert in their field e.g. obstetric, msk etc. Other • should not be necessary to involve outside assessors as consultant to registrar ratio is 1:4 • peers and patients can also be a source of assessment (MSF) • concern about bias with peer review • self-assessment is important

5.3.3.1 ***Qualified Radiologists***

Not surprisingly, the obvious choice with respect to who should assess the registrars – according to everyone that was interviewed – is the consultant radiologists from the same department. They are best qualified to assess imaging interpretation and procedural or practical skills but have the potential for personal bias (the use of "a template that eliminates subjectivity" may aid in this respect).

Consultant radiologists from other departments could be used in mock exams to determine examination readiness, but interviewees felt that it was impractical to use these assessors for the continuous assessment of registrars.

Opinions were divided on the role private radiologists could play in the assessment of registrars – most felt that it was problematic and complicated and some argued that even if it was possible, private radiologists have a different spectrum of activities and a different set of priorities to that of an academic department. There were those who suggested using private radiologists in mock exams to determine examination readiness. One of the departments who have a good working relationship with private radiologists, claim "very nice objective opinions" from the private radiologists, formulated during assessment of registrars during regular tutorial sessions. These assessments could be formalised, but would be limited to the IPX format. The use of private radiologist, it would seem, depends very much on the working relationship between the department and the local private radiologist (which clearly differs from city to city).

5.3.3.2 ***Non-Radiologists***

Consultants from other medical and surgical specialities are unlikely to contribute significantly to the continuous assessment of radiology registrars, according to those interviewed. One concern was that they might judge something other than the technical skills inherent to radiology. Another felt that they could probably assess certain and specific skills related to the assessor's speciality, but that it would have to be linked to a specific case and that they were not in a position to generalise their judgement outside that case.

One interviewee mentioned that where registrars rotated through other departments such as orthopaedics or nuclear medicine, some form of assessment and feedback could rightfully be expected.

Almost everyone felt that sonographers qualified (as experts in their field) to assess ultrasound procedural skills, but as one interviewee warned, it depended on the quality and experience of the individual sonographer.

Other possibilities mentioned during the interviews included peers (concerns about the critical nature of assessment and likely bias) and patients – and of course, very important, self-assessment.

5.3.4 The Formal and Standardised Training of Assessors Involved in the Assessment of Registrars

Question four asked: ***What are your views on assessors undergoing formal and standardised training in the assessment of registrars?*** This question explored the idea (taken from the literature) that formal training of assessors may reduce bias and improves the quality and reliability of assessments. The examples were (*cf.* Appendix B3):

- *Formal training of assessors will improve the reliability and quality of registrar assessments.*
- *Formal training of assessors will reduce, or possibly even eliminate, assessor bias.*
- *Assessor training should not be mandatory, but left to the discretion of the individual assessor.*

- *Assessor training is a waste of time and resources.*

The answers were coded and divided into categories (*cf.* Table 5.5).

Table 5.5 The formal and standardised training of assessors involved in the assessment of registrars.

THEMES	CATEGORIES AND CODES
Educating assessors is necessary	• "very important" • "improves standards and quality" • "not a waste of time and resources" • "you think you know until you speak to an educationalist" • it is important to recognise and understand exactly what it is that you want to assess • "know the curriculum and know the outcomes" • important to know how to use the different assessment methods • should contribute positively to the process of assessment • "should have a grasp of certain concepts" pertaining to assessing • not in favour of lengthy (in-depth) and formal assessment training [3], [6] • short informative sessions (e.g. workshops) should suffice [6] • one hour information session that explains basic principles • suggests four yearly follow-up information sessions/ refresher course • involve registrars in information sessions about assessment • university offers all newly employed consultants a week formal training in teaching methods, exam methods and assessment methods [4] • should definitely attend university training and refresh it every few years • sees the value in guidance and information (informative sessions) • essential for summative assessment
Assessor education should be optional for those who are interested	• "pie in the sky" • will not be able to train everyone – not everybody will be interested • you will have a core group of individuals interested in assessment and education • those really interested in assessment can pursue further training at their own discretion • problem of "joint staff appointment"
Not in favour of educating assessors	• will not make a huge difference to the outcome of assessments • rather employ "a template that eliminates subjectivity"

5.3.4.1 *In Favour of Educating Assessors*

Responses from the interviewed group could be divided into two groups – those who felt strongly that all assessors would benefit from some form of information session, and those who thought that it would not be possible to get everybody involved as not everyone will be interested, or that it would simply not make a huge difference to the outcome of the assessments (the interviewees in the latter group were incidentally also those most concerned about time and staffing issues in terms of continuous assessment and feedback).

Many – if not most – of the qualified radiologist who perform assessments are not familiar with or have an inadequate understanding of educational principles and concepts such as continuous assessment, workplace-based assessment, formative and summative assessment, performance-based assessment, competence, learning outcomes, exit outcomes, etc. Interviewees felt that it is important to recognise and understand exactly what it is that you want to assess and that it is important to know how to use the different assessment methods; this knowledge should contribute positively to the process of assessment. Most felt that short informative sessions that explains and clarifies the basic principles would suffice; none were in favour of in-depth formal training. Most universities offer newly appointed consultants formal training sessions in teaching methods, examination methods and assessment methods and these should be attended. There were also a few who suggested follow-up information sessions or refresher courses. From one of the interviews came the interesting suggestion to involve registrars in the information sessions about assessment, which would contribute to the understanding of their own assessments.

5.3.4.2 *Not in Favour of Educating Assessors*

One opinion held that there will always be those individuals who have no interest in assessment and only assess because they are required to – in light of this the interviewee suggested that training should be optional – left to those who were committed to, and interested in, training and assessment. One interviewee was quite negative towards mandatory training of any form and suggested, even if implemented, would unlikely improve the outcome of individual assessments.

5.3.5 Assigning Assessments

Question five wanted to know from the interviewee: ***How would you assign the different assessments?*** As can be seen from the examples of answers provided to this question, this question sought opinions on whether assessors should assess outside their area of interest or expertise and whether registrars should be allowed the freedom to choose their assessors. The examples were (*cf.* Appendix B3):

- *Distribute the assessments amongst the consultants within a department i.e. any consultant can and may perform any assessment, irrespective of modality or area of expertise.*
- *Assign specific assessments to specific consultant according to modality or area of expertise.*
- *Registrars should be allowed the freedom to choose their assessor*

The answers were coded and divided into categories (*cf.* Table 5.6).

Table 5.6 Assigning assessments [Table continues on next page].

THEMES	CATEGORIES AND CODES
Registrars choosing their assessors	• not in favour of registrar choosing their assessor [2], [3] (it promotes bias), [5] (fraught with problems), [6] (definitely not)
Assessments assigned to assessors	• assessment performed by consultant who is involved with that particular activity on a regular basis • monthly rotational assessment is undertaken by consultant responsible for that rotation • the consultant responsible for a specific assessment is predetermined • the allocated assessment usually falls within the consultant's area of interest • the ideal is assessment being performed by person stationed at a particular area of interest [6] (an expert in that field) – improves reliability, validity and fairness • the same consultant is always responsible for the same assessment – allows the consultant "to own the assessment" • owning the assessment allows the assessor to refine and develop the assessment • always performing the same assessment allows a more reliable assessment of performance by comparing a given performance with that of the other registrars – leads to

	standardisation and consistency • during first (junior) half of training programme assessment done by consultant responsible for modality • during second (senior) half of training programme assessment done by consultant responsible for organ system e.g. musculoskeletal • should be assessed by person responsible for determining the outcomes within a specific area – better equipped to do so [researcher's remark during interview] • "assign specific assessment to a specific consultant according to modality or area of expertise – it ensures better quality assessment"

5.3.5.1 *Registrars Choosing Their Assessors*

All interviewees were resolutely opposed to the idea of registrars choosing their assessors.

5.3.5.2 *Assessments Linked to Assessors*

The collective views from the various discourses could be summarised as – the consultant overseeing the rotation should perform the assessment and ideally the same consultant should always be responsible for the same assessment(s).

One of the interviewees pointed out that if the same consultant is always responsible for the same assessment it allows that consultant "to own that particular assessment". The same interviewee further argued that *owning* an assessment (the same assessor performing the same assessment repeatedly) enables the development, refinement and benchmarking of that assessment – this leads to standardisation and consistency, which in turn enhances fairness and reliability (vital characteristics of assessment).

Most of the interviewees would prefer to have a consultant assess within his area of interest or expertise, although this was often not the case as mostly different consultants rotated through the different modalities (such as MRI and CT) on a monthly basis. In departments where specific consultants are responsible for specialised domains (such as mammography or paediatric radiology), these consultants are responsible for the assessments within the individual domains. The radiology department at the UFS is fortunate to have specific consultants allocated to different modalities and different organ-based systems (for example the consultant for MRI is also the consultant responsible for neurological imaging and mammography) – an ideal situation for owning different assessments.

A slightly different view, held by one of the interviewees, divides the training programme into an initial junior half (general radiology with modality based rotations) and a latter senior half (subspecialty radiology with organ-based rotations). During the first (junior) half of the training programme, the consultant responsible for a specific modality will be responsible for the assessment, whilst the consultant responsible for a specific organ system e.g. musculoskeletal will perform the assessments during the second (senior) half of the rotation. The ideal, again, is that specific consultants own different modalities and or subspecialty domains.

Assessments should be linked to outcomes. In a system where assessors own certain assessments, it follows that they should be responsible for determining the outcomes of their specific assessments – yet another advantages to having a stable and structured assessment platform.

As so effectively summarised by one of the interviewees: "assign specific assessment to a specific consultant according to modality or area of expertise – it ensures better quality assessment".

5.3.6 Scheduling Assessments

Question six was: ***What, in your opinion, is the most appropriate way to schedule assessments?*** Examples of answers were provided in an attempt to inform the question and guide the participant's thoughts. These examples were (*cf.* Appendix B3):

- *A rigid assessment schedule which places assessment at the end of a (each) training period (e.g. after each rotation, at the end of each semester or yearly).*
- *A less formal assessment schedule that prescribes a requisite number of assessments per year, but at the same time gives the registrar the freedom to choose which and when an assessment takes place.*

The answers were coded and divided into categories (*cf.* Table 5.7).

Table 5.7 Scheduling assessments.

THEMES	CATEGORIES AND CODES
Structured approach	• prefers a structured approach to assessments that prescribes to the registrars [2], [3], [5] • "most registrars will do the minimum at the last moment" • a formal structured and prescriptive assessment programme is essential • standardised assessment schedule linked to rotations • assessment takes place at the end of the various initial rotations • linking assessments and specific outcomes may add value but will require a lot of extra work • 3 monthly assessment – performed at whichever station the registrar works on the day, performed by the consultant responsible for that station on the day • 6 monthly formal assessment across the board involving the entire registrar body – written MCQ's and a diagnostic image viewing session involving 30-60 slides • frequent structured WpBA's will benefit in theory – offset by service delivery and staffing issues • "ours is scheduled" – assessment at the end of a rotation • monthly rotation-based evaluations [at this institute]
Registrar centred approach	• not in favour of giving registrars the option to choose when assessments take place [2], [3]
Adaptive approach	• a schedule with guidelines and deadlines to ensure timeous assessments • freedom within these guidelines and deadlines – adapted to workflow and available (random) cases presenting at the modality

5.3.6.1 *Structured Approach*

Most of those interviewed preferred a structured approach to assessment – using terms such as formal, structured, standardised and prescriptive. At the time of the interviews most of the academic radiology departments (where the interviews were conducted) scheduled their assessments according to rotations, irrespective of the length of the rotation. Most rotations had a formal assessment at the end of the rotation or block, whereas others had a formal evaluation – that encompassed and reflected the entire period spent at that modality – at the end of the rotation. These scheduled assessments were usually over and above informal assessments performed as part of the daily activities.

5.3.6.2 *Registrar-Centred Approach*

Not one of the interviewees was in favour of giving registrars the option to choose when assessments should take place. Interviewees similarly took a dim view of prescribing a minimum amount of assessments for the year or semester and allowing registrars the freedom to meet the deadlines in their own time. As one of the interviewees commented – most registrars will leave it to the last minute to do the minimum.

5.3.6.3 *Adaptive Approach*

One of the interviewees, not in favour of a rigid assessment schedule, suggested the following alternative; an assessment schedule with guidelines and deadlines to ensure timeous assessments, but with the freedom within these guidelines and deadlines to adapt assessments to the workflow and available cases during the rotation. This seems reasonable and practical, and quite possibly the least disruptive way of conducting regular formal assessments amid a busy working radiology department.

From the interviews the researcher concluded that, for an assessment programme that prescribes regular and frequent formal assessments to work, it has to be scheduled and prescriptive. A structured assessment programme timeously informs everyone involved in the assessments, allowing assessors, registrars and programme directors enough time to plan ahead and schedule the assessments in order to meet deadlines.

5.3.7 The Challenges Related to the Implementation of a Formal and Structured Continuous Assessment Programme for Postgraduate Radiology Training

The seventh question posed to all interviewees was: ***What are the challenges, in your opinion, related to the implementation of a formal and structured continuous assessment programme for postgraduate radiology training in South Africa?***

The answers were coded and divided into categories (*cf.* Table 5.8).

Themes identified were:

- Consultants
- Time
- Administrative work
- Feedback
- Remediation

Table 5.8 Challenges related to the implementation of a formal and structured continuous assessment programme for postgraduate radiology training [Table continues on next page].

THEMES	CATEGORIES AND CODES
Consultants	Resources • "consultants are already very busy" – but should prioritise and attempt to get it done • "staffing definitely a big problem" • do not think there is enough people to do this • work within confines and do the best you can Participation • need a motivated consultant group • can be difficult to get everybody on board • the solution often lies in changing a mind set • main problem is buy-in (acceptance and willingness to participate) • recognise that not everyone is good at assessment
Time	Work and time demands • "workload a big problem" • "do not have the time to do all of them or that frequently" • time is needed for actual assessment, administrative work and feedback • careful not to overburden consultants with too many assessments • have to find time for one-on-one conversation with candidate Time management • "consultants not really that overworked" • a predetermined assessment schedule allows planning ahead at the beginning of the year • assessment becomes easier and less time consuming with repetition • solution lies in good planning • assessment programme should be structured in such a

	way as to have minimum impact on daily activities but maximum benefit to the registrars
Administrative work	• results of the various assessment over the entire training period have to be accumulated, assimilated and documented • especially if to be used in decisions about promotion • someone has to be responsible for this "body of evidence"
Feedback	• being done informally but not structured or consistently
Remediation	• usually neglected due to the confines of limited staff

5.3.7.1 *Consultants*

Consultants are qualified radiologists employed by the Department of Health of one of the eleven provinces in South Africa and appointed to a specific hospital within that province. Consultants are also members of staff of the affiliated University's School of Medicine.

Consultants are usually responsible for all formal assessments within a radiology department; the success and effectiveness of any assessment programme thus relies heavily on the cooperation of the consultants within the department. This was echoed by all interviewees and, alongside time, seen as the two main challenges facing any formal assessment programme. Most felt that consultants are already very busy – some said overworked – whereas others felt that through better planning and prioritising consultants would have more than enough time for assessments. The one opinion that stood out was the need for acceptance and willingness, from the consultants, to participate (consultants had to buy into the concept) – need a motivated consultant group; can be difficult to get everybody on board; and solution often lies in a changing a mind set were comments that reflected this view. One interviewee also noted that it was important to recognise that not everybody is good at assessment and that at the end of the day, one will have to plan according to and work within the confines of each department.

5.3.7.2 *Time*

It is true that time is needed for the actual assessment, feedback and the administrative tasks associated with formal assessment. Again there were those interviewees who simply felt that the system was already overburdened and that due to heavy workloads, there simply was not enough time to execute a formal assessment programme; their attitude reflected in comments like "[we] do not have the time to do all of them or that frequently". Fortunately, most of interviewees were more positive, suggesting that the solution lies in good planning, and pointing out that a predetermined assessment schedule allows you to plan ahead at the beginning of the academic year and that assessment becomes easier and less time consuming with repetition. One interviewee, in particular, warned that we should be careful not to overburden consultants with too many assessments and that an assessment programme should be structured in such a way as to have minimum impact on the daily activities of both consultant and registrar.

5.3.7.3 *Administrative Work*

During their training period, registrars build up a considerable body of evidence (of their performance during the training period) with most of the data coming from formal documented assessments. Someone has to be responsible for the accumulation, assimilation and documentation of the various assessments during the entire training period of each registrar.

5.3.7.4 *Feedback*

At least one interviewee was concerned about the (cumulative) time needed to provide feedback at the end of each assessment. In the researcher's opinion, this is not a problem, as feedback should take not take up a lot of time and is usually limited to once a month per candidate – as mentioned previously, the solution lies in a change in mindset and better planning.

5.3.7.5 *Remediation*

Remediation elicited much the same concern and the solution is the same as for feedback. It is important to note that, whilst the consultant may offer guidance and suggest certain actions, it remains the responsibility of the registrar to engage with these ideas and actions – they are ultimately responsible for their own performance.

5.3.8 The Viability of a Formal and Structured Continuous Assessment Programme for Postgraduate Radiology Training in South Africa

Question eight on the interview guide was: ***Given our limited resources in an already overburdened academic environment, what are your views on the viability of such a formal and structured continuous assessment programme for postgraduate radiology training in South Africa?***

The answers were coded and divided into categories (*cf.* Table 5.9).

Table 5.9 The viability of a formal and structured continuous assessment programme for postgraduate radiology training in South Africa [Table continues on next page].

THEMES	CATEGORIES AND CODES
Definitely viable and necessary	Deemed necessary • "ideal, viable and essential" • "definitely viable and it is necessary" • changing the postgraduate training environment necessitates changes in assessment Anticipated benefits • informs the registrar of his/her level of performance in comparison to the expected standard • identifies possible weaknesses and inadequacies which should be attended to, thus improving the overall performance of the registrar • a successful assessment can influence a candidate positively • the result of an assessment can motivate a candidate but this will depend on the registrar • the recognition of shortcomings should guide a registrar to improve in those areas • those registrars who cannot or will not address their shortcomings can be ejected from the programme on the back of continued failed assessments • a structured plan will make a difference when it comes to the final examination Implementation • "definitely viable and it is necessary but it needs time" • assessments have to be approved and standardised, and everyone from student to assessor have to be informed • a registrar should be informed about the assessments and consequences before starting with the training programme

	• "can work if we manage it ourselves" (managed by the department) – careful of too many assessments or assessments that do not contribute • implementation of a structured assessment programme should be done slowly and it should be formative
Reserved optimism	Should be attempted • try and build in something (formally structured) at the workface • "there should be a deliberate attempt to make it happen" • most are useful and should be done – look past constraints and find innovative ways to get them done Implementation • "definitely implementable at a relatively low level of frequency" • WpBA no more than once a month • 6 monthly formalised group assessment • find something that works for you

5.3.8.1 *Definitely Viable and Necessary*

"The changing postgraduate training environment necessitates changes in assessment; ideal, viable and essential; definitely viable and it is necessary but it needs time; can work if we manage it ourselves" – these were just some of the comments that reflected the generally positive attitude (of the interviewees) towards a formal assessment programme. One interviewee explained that an assessment programme continually informs the registrar of his or her level of performance as compared to the expected standard and that it identifies possible weaknesses and inadequacies that should be attended to, thus improving the overall performance of the registrar. Those registrars who could or would not address their shortcomings can then be ejected from the programme on the back of continued failed assessments. For this reason, assessments had to be approved and standardised and everyone, from student to assessor, had to be informed of and about the assessments. Despite the positivism, interviewees warned that the implementation of a structured assessment programme should be done slowly and it should be formative: another warned that we should be careful not to include too many assessments or assessments that do not contribute to learning and training of the registrar.

An opinion that put the assessment programme in context came from a colleague who said that a structured assessment programme would make a difference when it comes .to the final examination.

5.3.8.2 *Reserved Optimism*

A couple of interviewees were more reserved in their optimism towards a structured and formal assessment programme. Though the saw the value and merit in such a programme they had reservations about the viability, underpinned by concerns about increasing workloads, increasing demands on time and staffing issues. They did nevertheless concede that "there should be a deliberate attempt to make it happen" and "[that it is] definitely implementable at a relatively low level of frequency".

5.4 SUMMATIVE DISCUSSION

During the period August 2014 to November 2014, six semi-structured interviews were conducted with pivotal role players in postgraduate radiology education and assessment in South Africa. After six interviews the process was saturated and no new views or opinions emerged.

There was a lengthy delay between the first two interviews and the latter group of four. This delay was, for the most part, due to the researcher's (and some of the interviewees') participation in the College (CMSA) Radiology Final Examination and the M.Med Radiology Final Examination, followed by the unavailability of one of the interviewees for a period of time after the College Radiology Final Examination. The delay had no negative effect on the subsequent interviews. In fact, the delay gave the researcher time to analyse and code the initial two interviews, which then informed the subsequent interviews. The researcher also had time to review his interview technique and obtain clarity about the expected outcomes of the interviews. Both these actions contributed to the quality of the last four interviews.

5.5 INTERPRETIVE DISCUSSION

The interviews held no real surprises and there was an expected similarity in terms of opinions concerning postgraduate radiology training and assessment in South Africa. Whereas some institutions had a fairly structured assessment programme (which included formal documented assessments), others were mostly dependent on informal assessments (observations) of performance. Although all interviews acknowledged the importance of feedback, few dedicated time to formal feedback, and routine feedback following formal assessments was the exception. From the interviews it would seem that remedial action also happens very infrequently. Across the board, all interviewees acknowledge the value and importance of continuous and formative assessment, both formal and informal.

It came as no surprise that time and staffing issues were seen as major challenges, obstacles even, in the continuous and frequent assessment of registrars – although most felt that careful planning and a shift in mindset would go a long way to resolving these issues.

The level of understanding of the various educational concepts, their application and the different workplace-based assessments varied amongst the interviewees (although not markedly). Often concepts that seemed unfamiliar at first, proved to be familiar (or not as new or different as the interviewee initially thought) as discussion around the concepts continued. Much of what is happening in the different academic radiology departments (in terms of continuous assessment) resonates with the concepts discussed during the interviews. Although assessment in its current form provides some proof of learning, most of the time though, it seems not to contribute to registrar training, nor document progress.

In the end, the interviews elicited many valuable opinions; these opinions were instrumental in the development of the proposed assessment programme for postgraduate radiology training at the UFS.

5.6 CONCLUSION

This chapter comprises the analysis and coding of the content of the semi-structured interviews – conducted during the period August 2014 to November 2014 – and discussions of the individual themes identified during analysis of the six semi-structured interviews.

The next chapter, Chapter 6, titled **A Competency-Based Continuous Assessment Programme as part of a Revised Curriculum for the Postgraduate Training at the University of the Free State,** will describe in detail the proposed assessment programme for the postgraduate training at the University of the Free State, as well as the changes made to the curriculum in order to both update the content and accommodate the formal and structured assessment programme.

CHAPTER 6

A COMPETENCY-BASED CONTINUOUS ASSESSMENT PROGRAMME AS PART OF A REVISED CURRICULUM FOR POSTGRADUATE RADIOLOGY TRAINING AT THE UNIVERSITY OF THE FREE STATE

6.1 INTRODUCTION

> *"Professionals in medical imaging fit the criteria of providing a service to others within a strict code of practice and ethics that provides a framework of values, attitudes and abilities needed to be a member of the profession operating in a multidisciplinary healthcare team"* (Calman 2007 in Engel-Hills & Chhem 2012:4).

The aim of a postgraduate educational programme is to produce a competent self-regulating professional. In the past, becoming a professional relied on the trainee being in the profession, where he (or she) could absorb the necessary "knowledge, abilities, behaviour and conduct from experts within the profession" (Engel-Hills & Chhem 2012:4). Educational philosophy has, however, shifted towards a more structured approach underpinned by outcomes and competencies. Becoming a professional still requires the necessary professional knowledge, skills, attitudes and behaviour but now also demands the demonstration of a certain level of performance, which depends on the attainment of prerequisite competencies. Despite this shift in educational philosophy, developing this level of competence is still dependent on being in the profession, where learners are given the opportunity to develop expertise whilst working alongside experts in the profession.

An educational programme typically consists of a curriculum, instructional method and assessment (Gunderman 2012:49). This research project addressed two of these components – the curriculum and assessment aspects of the postgraduate radiology training programme at the UFS – with the purpose of ensuring a quality postgraduate radiology education and training programme capable of serving the needs of the trainees and the profession.

This chapter discusses the proposed changes to the postgraduate radiodiagnosis curriculum for postgraduate radiology education and training at the UFS, as well as the various aspects of the continuous assessment programme, designed to compliment the curriculum.

6.2 DEFINING COMPETENCE IN POSTGRADUATE RADIOLOGY EDUCATION

A competent radiologist is a compleat (complete) radiologist. The Merriam-Webster Dictionary (2014a:Online) defines *compleat* (an archaic spelling of complete) as *having all [the] necessary or desired elements or skills.*

In an effort to ensure the quality of graduate radiologists, the profession has incorporated roles and competencies – adapted from the CanMEDS framework of essential physicians competencies – into radiology postgraduate training programmes worldwide. The CanMEDS framework describes a number of key competencies intrinsic to all competent physicians – function effectively as a consultant; establish and maintain relevant knowledge, skills and attitudes; perform complete and appropriate assessment of a patient; use preventative and therapeutic interventions effectively; demonstrate proficient and appropriate use of procedural skills; and seek appropriate consultation from other health professionals (Wang 2012:55).

The effective application of these CanMEDS competencies to radiology requires transposition into a radiological context. Table 6.1 demonstrates how the CanMEDS competencies can be applied to radiology.

Table 6.1 CanMEDS competencies relevant to radiology (taken from Wang 2012:59) [Table continues on next page].

COMPETENCY	RADIOLOGICAL COMPETENCIES
Consultant	Discuss indications for and type imaging Review of case findings and diagnoses Written and oral reports on imaging findings and diagnoses Recommend additional imaging tests or procedures
Knowledge expert	Radiological anatomy Imaging instrumentation and physics Pathology and relevant epidemiology Imaging findings in disease and normal conditions Modality-based expertise in imaging applications and image quality System-based expertise in regional and organ-based diagnosis

Patient assessment	Imaging test selection and appropriateness Radiation safety and ALARA Contrast agent safety Consent for imaging procedures
Use interventions effectively	Modified approaches to reduce radiation and contrast exposure Reduction of risk for contrast reactions in selected cases Selection and use of image-guided interventional procedures Be trained and experienced in interventions
Procedural skills	Region, organ, and modality-specific skills Image-guided injections Image-guided biopsy Image-guided drainage of hollow organs or collections Fluoroscopic procedures Performance of ultrasound studies Angiographic and venographic procedures, including diagnostic studies, revascularisation and embolisation
Appropriate external consultation	Appropriate use of published medical literature and reference materials Recognition of limits of radiological expertise Recommendation of additional imaging tests Recommendation for non-imaging tests or interventions Recommendation of other imaging experts

The competent present-day radiologist is therefore expected to fulfil many roles: nevertheless, the role of medical expert remains central to all of these. According to Wang (2012:55) the role of medical expert in radiology requires:

- a foundation of broad and deep anatomical knowledge,
- a practical understanding of medical imaging instrumentation and physics,
- matrix knowledge of diseases across most organ systems,
- efficient region-specific, imaging-specific, and disease-specific search for abnormal findings,
- deductive and inductive reasoning,
- integration with internal and external knowledge bases,
- synthesis of one or more probable diagnoses,
- understanding of the impact of imaging and imaging-based diagnoses in clinical management, and finally
- the use of these competencies to guide, plan, and sometimes perform treatment of the patient.

Epstein and Hundert (2002:226) argue that professional competence is developmental and context-dependant and as such define professional competence as:

> *"the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values and reflection in daily practice for benefit of the individual and the community being served"* (Epstein & Hundert 2002:226).

This definition highlights the attributes of a competent professional namely knowledge, technical or procedural skills, the ability of clinical reasoning, communication, a set of values inherent in the profession and the ability to reflect on one's own performance in comparison to that expected by the profession (self-assessment and self-reflection).

Applying this concept of competence to radiology requires translation of the attributes into a radiological context:

Knowledge:

- a body of knowledge, relevant to the South African disease profile, determined by the profession and described in a curriculum
- a level of knowledge that, when integrated with the required skills and behaviours, results in the successful performance of demanding, complicated and highly skilled tasks inherent to radiology (level four of Miller's triangle of clinical competence which refers to performance integrated into practice)
- proficiency can and should be assessed.

Technical or Procedural skills:

- a set of procedural skills, essential to the effective daily functioning of a practicing radiologist, determined by the profession and described in a curriculum
- a level of functioning described in level four of Miller's triangle
- proficiency can and should be assessed.

Clinical Reasoning:

- cannot be taught but can be developed through experience
- proficiency can and should be assessed
- it is, however, difficult (if at all possible) to define descriptors and outcomes.

Communication:

- can be developed through experience
- adequacy can be assessed (formatively but not summatively)
- it is difficult to define descriptors and outcomes for communication but certain minimum prerequisites can be defined if necessary (e.g. proficiency in English as a second language).

Values:

- some values can be taught (such as ethics)
- it is difficult to define descriptors and outcomes but certain minimum prerequisites can be defined where necessary (for example punctuality)
- can be difficult to assess individually – will likely form part of an overall assessment.

Self-Assessment and Reflection:

- these are important abilities, that have to be developed during a registrar's training
- it holds the key to independent continued learning and maintaining competence after qualification as a radiologist.

A curriculum detailing the prerequisite knowledge, skills and behaviours serves as a declaration of quality (of a graduate radiologist) – something that has gained importance in the quality-controlled environment of today's audit culture. Apart from being a statement of quality, such a detailed curriculum can provide the framework that guides a registrar's training and assessment. Outcomes linked to a timeline and an integrated structured assessment programme can ensure the gradual development of competence over the prescribed training period.

Part of this research study therefore set to determine which of these attributes could and should be included in a postgraduate radiology curriculum – in the context of postgraduate radiology education in South Africa – effectively defining the attributes of a competent graduate radiologist in South Africa.

6.2.1 The Proposed Content of the Curriculum

As mentioned, the content of a curriculum defines the attributes of a graduate: linking these outcomes to a timeline effectively guides a registrar through the various stages of his or her training. It not only affords registrars the opportunity to assess their own (level of) performance against that prescribed by the curriculum for their level of training, it also guides the scheduled formal (predominantly formative) assessment of registrars during their training.

Not all the knowledge and procedures prescribed in the curriculum are equally important for the competent performance of daily activities as a graduate radiologist, especially in an academic environment where the general aim is still to train a general radiologist. South Africa is not yet in a position to offer subspecialty training to radiology registrars (except for diplomas in paediatric and interventional radiology). Postgraduate fellowships in different radiology sub-specialities are usually acquired internationally, after which the radiologist either remains overseas or joins a private radiology practice in South Africa – these fellowships are mostly lost to South African academic radiology. A curriculum that describes levels of competence will help the registrar focus on what is most relevant and important, but still ensure a generally well-informed candidate. With this in mind and in accordance with discussions held with the promoters, the researcher suggests dividing the curriculum into levels of increasing competence. Each level represents a defined instructional period within the training period, beginning with the entrance level and ending in a postgraduate level. Each level is described in terms of outcomes that the registrar should acquire during that stage.

In line with the aims and scope of this study (*cf.* 1.4.2 and 1.5), the revision of the curriculum is by no means comprehensive. The requisite knowledge is not defined in any great detail. Identifying and defining exactly which anatomy, pathology, physics and imaging findings in disease and normal conditions the registrar needs to know is ideally left to the profession's governing body and falls outside the scope of this research study (*cf.* 1.4.2). Then again, as one of the interviewees remarked during the semi-structured interviews – "any textbook is a structured curriculum".

A more detailed description of each of the proposed levels follows.

6.2.1.1 *Level One*

This level applies to registrars newly appointed to the postgraduate radiology training programme – it signifies the start of their formal and accredited radiology training. In line with current admissions criteria (at the UFS) the candidate has to be a qualified medical doctor and have successfully completed the Fellowship of the College of Radiologists of South Africa Part I examination (which includes Radiation Physics and Imaging Anatomy). The registrar will invariable have varied levels of experience and expertise in diagnostic radiology (of which most, if not all, will have been acquired outside a HPCSA accredited diagnostic radiology training programme).

At this level, the registrar generally lacks the ability to interpret radiological diagnostic imaging, or perform diagnostic or therapeutic radiological procedures, safely and accurately.

6.2.1.2 *Level Two*

The learning outcomes of Level Two are aimed at and confined to emergency radiology. Attainment of the outcomes will enable the registrar to perform supervised independent on-call radiology duties.

Upon completion of this level, the registrar is expected to have a basic knowledge of the specified medical and surgical conditions (*cf.* Table 6.2). The consultant body of the department should be satisfied that the registrar is proficient in interpreting and reporting a range of emergency radiological imaging independently, safely and with an acceptable level of accuracy.

Upon completion of this level, the registrar should be proficient in performing the diagnostic and/or therapeutic radiological procedures as specified for this level (*cf.* Table 6.2). The consultant body of the department should be satisfied that the registrar is able to perform the diagnostic and/or therapeutic radiological procedures independently, safely and with an acceptable level of accuracy.

The registrar is required to spend a minimum period of time (as determined by the radiology department) at Level Two before he or she is allowed to undertake supervised independent on-call radiology duties. During this period the registrar can be expected to shadow more senior registrars performing after-hour radiology on-call duties.

Table 6.2 describes the knowledge and procedural skill outcomes relevant for this level. The content of the table – the proposed syllabus – was compiled (by the researcher) from the *Diagnostic Imaging: Emergency textbook* (Jeffrey, Manaster, Gurney, Zimmerman, Curé & Donnelly 2007:xix-xxiv). Knowledge is divided into categories A and B and skills are divided into categories C and D. *For this Level, as for all subsequent Levels, category A is equivalent to the basic option and category B equivalent to the advanced option under heading One of the Delphi survey, whilst category C is equivalent to the basic option and category D equivalent to the advanced option under heading Two of the Delphi survey (cf. 4.2.1.1).*

- **Category A:** represents a basic level of knowledge – defined as equivalent to the level of knowledge in a general radiology textbook such as *Fundamentals of Diagnostic Radiology* (2012) or *Grainger & Allison's Diagnostic Radiology* (2014).
- **Category B:** represents an advanced level of knowledge – defined as a more detailed and more in-depth knowledge than that of the basic level; such a level of knowledge can come from specialised textbooks such as *Amyirsys' Diagnostic Imaging Series* and radiology reference and review articles.
- **Category C:** represents a basic skill level – the registrar is able to perform the radiological procedure under supervision, with or without assistance from a more competent individual (preferably a qualified radiologist).
- **Category D:** represents an advanced skill level – the registrar is able to perform the radiological procedure safely and competently, without the assistance or supervision of a more competent individual (usually a qualified radiologist).

Table 6.2 Level Two radiology-specific learning outcomes [Table continues on next pages].

KNOWLEDGE:	**A**	**B**
Knowledge about routine emergency conditions:		
CNS - brain:		
• ischaemia		
• intracranial haemorrhage		
• dural sinus thrombosis		
• diffuse axonal injury		
• intracranial herniation		

• infections		
CNS – head and neck:		
• skull fractures		
• extracranial vascular injury		
• periorbital cellulitis		
CNS - spine		
• various vertebral fractures		
• hyperflexion, hyperextension and hyperflexion-rotation injuries cervical spine		
Chest/cardiovascular		
• pneumothorax and pneumomediastinum		
• traumatic aortic injury		
• aortic dissection		
• pulmonary emboli		
• acute pulmonary oedema		
• foreign body inhalation		
Abdomen/pelvis:		
• hepatic trauma		
• splenic trauma		
• renal trauma		
• pancreatic trauma		
• duodenal trauma		
• testicular trauma		
• small bowel obstruction		
• intussusception		
• appendicitis		
• volvulus – sigmoid, caecum and midgut		
• cholecystitis		
• acute pancreatitis		
• renal calculi		
• testicular torsion		
• ovarian torsion		
Musculoskeletal:		
• common fractures – upper and lower extremities		
• fractures unique to paediatric age group		
• child abuse (NAI)		
SKILLS:	**C**	**D**
Interpret emergency plain x-rays		
Perform and interpret emergency fluoroscopy procedures:		
1) water-soluble contrast swallow		
2) contrast enema – paediatric and adult		
3) high-pressure cystogram		
Perform a pneumatic reduction for paediatric intussusception		
Perform and interpret emergency ultrasounds:		
1) FAST/ abdominal ultrasound		
2) transabdominal pelvis ultrasound		
3) scrotal ultrasound		
4) ultrasound of the lower limb veins for DVT		
5) pericardial ultrasound		
Interpret emergency CT imaging:		

1) brain – haemorrhage, ischaemia, sinus thrombosis and infections		
2) skull fractures		
3) cervical, thoracic and lumbar spine injuries		
4) neck – penetrating neck injury		
5) chest – pulmonary embolism, traumatic aortic injury, aortic dissection and pneumomediastinum		
6) abdomen – blunt and penetrating abdominal trauma, pancreatitis, appendicitis, vascular emergencies, renal calculi, abscesses		
7) pelvis – fractures, bladder rupture, abscesses		
Write clear, accurate and succinct reports		

6.2.1.3 *Level Three*

Level Three is a mid-training level and aimed at proficiency in general radiology at a basic level. This level generally coincides with the first half of the training programme.

Upon completion of this level, the registrar is expected to have accumulated a body of knowledge that encompasses radiological anatomy, imaging instrumentation and physics, pathology and relevant epidemiology, imaging findings in disease and normal conditions, modality-based expertise in imaging applications and image quality, system-based expertise in regional and organ-based diagnosis – of which the breadth and depth has been described in the Level Three curriculum (*cf.* Table 6.3). The consultant body of the radiology department should be satisfied that the registrar is proficient in interpreting and reporting a range of radiological imaging independently, safely and with an acceptable level of accuracy for this level of training.

Upon completion of this level, the registrar should be proficient in performing the diagnostic and/or therapeutic radiological procedures as specified for this level, independently, without supervision and safely (*cf.* Table 6.3). The consultant body of the department should be satisfied that the registrar is able to perform these diagnostic and/or therapeutic radiological procedures independently, safely and with an acceptable level of accuracy.

It is expected that in dealing with the rest of the diagnostic imaging and radiological procedures a registrar encounters on a day-to-day basis, the registrar will be supervised and assisted by a qualified radiologist.

A registrar at this level, may in addition to the outcomes specified for this level, already have the ability to interpret more difficult diagnostic imaging studies and perform more complex diagnostic and/or therapeutic radiological procedures under supervision, with or without assistance, from a qualified radiologist.

Table 6.3 describes the knowledge and procedural skill outcomes relevant for this level. The content of the table – the proposed syllabus – was complied by the researcher, based on the results of the Delphi survey (*cf.* Chapter 4). Knowledge is divided into categories A and B and skills are divided into categories C and D.

- **Category A:** represents a basic level of knowledge – defined as equivalent to the level of knowledge in a general radiology textbook such as *Fundamentals of Diagnostic Radiology* (2012) or *Grainger & Allison's Diagnostic Radiology* (2014).
- **Category B:** represents an advanced level of knowledge – defined as a more detailed and more in-depth knowledge than that of the basic level; such a level of knowledge can come from specialised textbooks such as *Amyirsys' Diagnostic Imaging Series* and radiology reference and review articles.
- **Category C:** represents a basic skill level – the registrar is able to perform the radiological procedure under supervision, with or without assistance from a more competent individual (preferably a qualified radiologist).
- **Category D:** represents an advanced skill level – the registrar is able to perform the radiological procedure safely and competently, without the assistance or supervision of a more competent individual (usually a qualified radiologist).

Table 6.3 Level Three radiology-specific learning outcomes [Table continues on next pages].

BREAST IMAGING		
KNOWLEDGE:	**A**	**B**
The anatomy of the breast:		
1) normal anatomy		
2) normal anatomical variants		
Age related breast changes		
The physics of mammography image production and how it affects image quality		
Knowledge of the technical aspects of breast imaging:		
1) mechanism of obtaining and optimizing film-screen or digital mammograms		
2) imaging and workstation display of digital mammograms		
The respective roles (including indications and limitations) of the following imaging studies in terms of breast imaging:		
1) mammography		
2) breast ultrasound		
3) elastography		

4) ductography		
BI-RADS (Breast Imaging Reporting and Data System)		
CARDIAC IMAGING		
KNOWLEDGE:	**A**	**B**
Cardiac vascular anatomy:		
1) normal anatomy		
2) normal anatomical variants		
SKILLS:	**C**	**D**
Interpret plain chest radiographs accurately and safely		
Perform and interpret ultrasound for pericardial effusion		
Write clear, accurate and succinct reports		
THORACIC IMAGING		
KNOWLEDGE:	**C**	**D**
Applied anatomy relevant to radiological diagnosis of thoracic disease		
1) normal anatomy		
2) normal anatomical variants		
Terminology relevant to thoracic imaging (Fleischner Glossary)		
The appearance and positioning of lines, tubes and devices		
The management of the solitary pulmonary nodule (Fleischner guidelines)		
The respective roles (including indications and limitations) of the following imaging studies in terms of thoracic imaging:		
1) chest radiograph		
2) thoracic CT and CT Angiography		
SKILLS:	**C**	**D**
Interpret plain chest radiographs accurately and safely		
Report a certain percentage (of a predetermined amount) of chest radiographs correctly in a specified amount of time		
Perform and interpret fluoroscopic diaphragm screening		
Protocol and interpret routine CT imaging studies relevant to thoracic imaging (including CT pulmonary angiography)		
Write clear, accurate and succinct reports		
GASTROINTESTINAL IMAGING		
KNOWLEDGE:	**A**	**B**
Normal anatomy of the:		
1) gastrointestinal tract		
2) hepatobiliary tract		
3) pancreas		
Normal variant anatomy of the:		
1) gastrointestinal tract		
2) hepatobiliary tract		
3) pancreas		
The respective roles (including indications and limitations) of the following imaging studies in terms of gastrointestinal imaging:		
1) barium/contrast screening studies		
2) ultrasound		
3) CT		
4) MRI/ (including MRCP)		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to GIT imaging		
Perform and interpret a range of relevant fluoroscopy studies		

1) barium swallow		
2) barium meal		
3) barium follow through / enteroclysis		
4) barium enema		
Perform and interpret an abdominal ultrasound for the assessment of abdominal viscera		
Protocol and interpret routine CT imaging studies relevant to GIT imaging		
Write clear, accurate and succinct reports		
Perform image guided drainage of intra-abdominal fluid collections and abscesses		
NEPHROLOGICAL AND UROLOGICAL IMAGING		
KNOWLEDGE:	**A**	**B**
Applied anatomy relevant to radiological diagnosis of urological imaging:		
1) normal anatomy		
2) normal variant anatomy		
The respective roles (including indications and limitations) of the following imaging studies in terms of urological imaging:		
1) ultrasound		
2) fluoroscopy		
3) CT (including CT urography)		
Renal dialysis:		
1) indications		
2) complications associated with peritoneal dialysis		
Renal transplant:		
1) role of imaging in the workup to renal transplant - donor		
2) role of imaging in the workup to renal transplant - recipient		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to urology and nephrology imaging		
Perform and interpret a range of fluoroscopy studies relevant to nephrology and urology:		
1) MCUG (micturating cystourethrogram)		
2) IVP (intravenous pyelogram)		
3) retrograde urethrogram		
4) cystogram		
Perform and interpret a range of ultrasound studies relevant to nephrology and urology:		
1) ultrasound of the urinary tract (kidney, ureters and bladder)		
2) scrotal ultrasound		
Protocol and interpret routine CT imaging studies relevant to nephrology and urology (including CT urography)		
Write clear, accurate and succinct reports		
GYNAECOLOGICAL IMAGING		
KNOWLEDGE:	**A**	**B**
Applied anatomy relevant to radiological diagnosis of gynaecological imaging:		
1) normal anatomy		
2) normal variant anatomy		
The respective roles (including indications and limitations) of the following imaging studies in terms of gynaecological imaging:		
1) transabdominal gynaecological ultrasound		
2) endovaginal gynaecological ultrasound		
3) hysterosalpingography (HSG)		
4) defecography		

5) abdomen and pelvis CT		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to gynaecological imaging		
Perform and interpret transabdominal pelvis (gynaecological) ultrasounds		
Perform and interpret hysterosalpingograms (HSG)		
Protocol and interpret routine CT imaging studies relevant to gynaecological imaging		
Write clear, accurate and succinct reports		
OBSTETRIC IMAGING		
KNOWLEDGE:	**A**	**B**
The use of intravenous iodated contrast medium in a pregnant patient		
Imaging of a pregnant patient with suspected pulmonary embolism		
Imaging of a pregnant patient with acute abdominal pain		
Imaging of a pregnant patient with vaginal bleeding		
The role of different imaging modalities in pregnant patients:		
1) plain x-rays		
2) ultrasound		
3) CT		
SKILLS:	**C**	**D**
Advise on the most appropriate imaging modality for a given clinical problem in relation to a pregnant patient		
Perform transabdominal obstetric ultrasounds for confirmation of pregnancy and/or foetal viability		
Perform transabdominal first trimester obstetric ultrasounds		
NEUROLOGICAL IMAGING		
KNOWLEDGE:	**A**	**B**
The applied anatomy relevant to spinal and cranial imaging:		
1) normal anatomy		
2) normal variant anatomy		
MRI physics		
MRI contrast media – indications, side effects and complications:		
Knowledge of the technical aspects and principles of MRI:		
1) magnets		
2) gradient coils		
3) RF coils		
4) magnetic susceptibility		
5) nuclear magnetic moments		
6) effect of external magnetic field		
7) nuclear precession		
8) equilibrium magnetisation		
9) significance of radio frequency (RF) pulse		
10) resonance & Larmor frequency		
11) free induction decay (FID)		
12) chemical shift		
13) relaxation		
14) pulse sequences		
15) production of the image		
16) image quality		
17) hazards and bio-effects		
18) fat suppression and fat imaging		
19) contrast imaging		

20) flow effects		
The respective roles (including indications and limitations) of the following imaging studies in terms of neuroimaging:		
1) CT		
2) CT Angiography		
3) CT myelography		
4) MRI		
5) MR Angiography		
6) MR diffusion imaging		
SKILLS:	**C**	**D**
Interpret emergency radiographs of the skull and spine		
Perform and interpret image guided lumber punctures and myelography		
Interpret emergency CT imaging of the head and spine		
Protocol and interpret routine CT imaging relevant to neurological imaging including CTA		
Protocol and interpret a range of CT imaging studies relevant to neurological imaging:		
1) CT myelography		
Interpret emergency MRI imaging of the head and spine		
Protocol and interpret routine MR imaging relevant to neurological imaging including MRA		
Protocol and interpret a range of MR imaging studies relevant to neurological imaging:		
1) MR diffusion imaging		
Write clear, accurate and succinct reports		
EXTRACRANIAL HEAD AND NECK IMAGING		
KNOWLEDGE:	**A**	**B**
The applied anatomy relevant to head and neck imaging:		
3) normal anatomy		
4) normal variant anatomy		
The respective roles (including indications and limitations) of the following imaging studies in terms of head and neck imaging:		
1) plain x-rays		
2) fluoroscopy studies		
3) video fluoroscopy (swallowing)		
4) sialography		
5) dacrocystography		
6) ultrasound		
7) CT and CT Angiography		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to head and neck imaging		
Perform and interpret ultrasound studies relevant to extracranial head and neck imaging excluding carotid ultrasound and ultrasound of the thyroid and parathyroids		
Protocol and interpret routine CT imaging studies relevant to extracranial head and neck imaging (including CTA)		
Interpret nuclear studies relevant to head and neck imaging		
Write clear, accurate and succinct reports		
MUSCULOSKELETAL IMAGING		
KNOWLEDGE:	**A**	**B**
The applied anatomy relevant to musculoskeletal imaging:		
1) normal anatomy		
2) normal variant anatomy		

Terminology relevant to musculoskeletal imaging		
The principles of bone and joint lesion characterisation		
The respective roles (including indications and limitations) of the following imaging studies in terms of musculoskeletal imaging:		
1) plain x-rays		
2) arthrography		
3) ultrasound		
4) CT		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to musculoskeletal imaging		
Protocol and interpret routine CT imaging studies relevant to musculoskeletal imaging		
Write clear, accurate and succinct reports		
PAEDIATRIC IMAGING		
KNOWLEDGE:	**A**	**B**
The anatomy relevant to paediatric imaging:		
1) normal anatomy		
2) normal variant anatomy		
Age related anatomical changes especially in		
1) urogenital imaging		
2) neuroimaging		
3) musculoskeletal imaging		
4) cardiac imaging		
Radiation safety dosimetry		
Dose reduction in relation to paediatric diagnostic imaging		
ALARA principles for modalities using ionizing radiation		
Practice-based imaging guidelines and appropriateness criteria (e.g. the ACR Appropriateness Criteria and Practice Guidelines)		
The respective roles (including indications and limitations) of the following imaging studies in terms of paediatric imaging:		
1) plain x-rays		
2) fluoroscopy studies		
3) ultrasound		
4) CT		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to paediatric imaging		
Perform and interpret a range of relevant ultrasound studies		
1) oesophagram		
2) upper GI study with small bowel series		
3) barium enema (including anorectal malformation studies)		
4) reduction of intussusception		
5) micturating cysto-urethrogram (MCUG or VCUG)		
6) cystograms		
Perform and interpret a range of relevant ultrasound studies		
1) abdominal ultrasounds (including identification of intussusception, pyloric stenosis and appendicitis)		
2) renal ultrasound (renal, bladder and pelvis)		
3) transabdominal pelvis ultrasound		
4) hip ultrasound		
5) cranial ultrasound (neonatal head ultrasound)		
6) scrotal ultrasound		

7) ultrasound of the neck		
Write clear, accurate and succinct reports		
VASCULAR IMAGING		
KNOWLEDGE:	**A**	**B**
The vascular anatomy of all organs and peripheral circulation:		
1) normal anatomy		
2) normal variant anatomy		
The anatomy relevant to imaging examinations of:		
1) gastrointestinal tract		
2) trauma		
3) peripheral vascular disease		
4) cerebrovascular disease		
5) aorta		
6) dialysis access		
7) veins and vena cava		
Aorta aneurysms:		
1) diagnostic imaging		
The respective roles (including indications and limitations) of the following imaging studies in terms of vascular imaging:		
1) plain x-rays		
2) ultrasound		
3) CT Angiography		
4) MR Angiography		
5) DSA catheter directed angiography		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to vascular disease		
Perform and interpret the following catheter directed angiography:		
1) aortagram		
2) outflow of the lower limbs		
Perform and interpret vascular ultrasound:		
1) ultrasound of the upper limb veins (including subclavian and axillary veins)		
2) ultrasound evaluation of abdominal aorta aneurysm		
3) ultrasound of the lower limb veins for deep vein thrombosis		
Write clear, accurate and succinct reports		

6.2.1.4 *Level Four*

Level Four represents the graduate level and is aimed at a proficiency in general radiology that will allow the candidate to function as an independent general radiologist, integrating all graduate attributes roles in order to provide optimal, ethical, comprehensive and patient centred care. This level thus incorporates diagnostic radiology exit level outcomes. Level Four will usually coincide with the latter half of the training period.

Whereas Level Three focused on a more general and integrated approach to radiology, with modality-based monthly rotations, Level Four approaches the radiology training in line with the individual organ-based radiology sub-specialities. This level, however, is not a super-speciality level but merely represents an approach to radiology learning. Instead of focussing on a single modality, the registrar now has the opportunity to focus on an organ system, integrating the various modalities used in the process of making a diagnosis. This level therefore also requires a deeper learning and understanding of radiological anatomy, imaging instrumentation and physics, pathology, imaging findings in disease and normal, modality-based expertise in imaging applications and image quality and system-based expertise in regional and organ-based diagnosis.

The level of knowledge required at this stage is equal to that necessary to pass the Fellowship of the College of Radiologists of South Africa Part II (final) examination.

Upon completion of this level, the registrar is expected to have accumulated a body of knowledge (*cf.* Level 6.4) that will allow the individual to function safely and effectively as an independent graduate radiologist. The consultant body of the radiology department should be satisfied that the registrar is proficient in interpreting and reporting a range of radiological imaging independently, safely and with an acceptable level of accuracy for this level of training.

Upon completion of this level, the registrar should also be proficient in performing the diagnostic and/or therapeutic radiological procedures as specified for this level (*cf.* Table 6.4), independently, without supervision and safely. The consultant body of the department should be satisfied that the registrar is able to perform these diagnostic and/or therapeutic radiological procedures independently, safely and with an acceptable level of accuracy.

Table 6.4 describes the knowledge and procedural skill outcomes relevant for this level. The content of the table – the proposed syllabus – was complied by the researcher, based on the results of the Delphi survey (*cf.* Chapter 4). Knowledge is divided into categories A and B and skills are divided into categories C and D.

- **Category A:** represents a basic level of knowledge – defined as equivalent to the level of knowledge in a general radiology textbook such as *Fundamentals of Diagnostic Radiology* (2012) or *Grainger & Allison's Diagnostic Radiology* (2014).
- **Category B:** represents an advanced level of knowledge – defined as a more detailed and more in-depth knowledge than that of the basic level; such a level of knowledge can come from specialised textbooks such as *Amyirsys' Diagnostic Imaging Series* and radiology reference and review articles.
- **Category C:** represents a basic skill level – the registrar is able to perform the radiological procedure under supervision, with or without assistance from a more competent individual (preferably a qualified radiologist).
- **Category D:** represents an advanced skill level – the registrar is able to perform the radiological procedure safely and competently, without the assistance or supervision of a more competent individual (usually a qualified radiologist).

Through the use of colour coding Table 6.4 (*cf.* examples immediately below this paragraph) indicates during which half of the training programme that skill should be acquired:

This skill should be acquired during the first half of the training programme	

This skill should be acquired during the second half of the training programme	

Colour coding of the cells in Table 6.4 (*cf.* examples immediately below this paragraph) indicate which outcomes were transferred from Level Three and which are unique to Level Four. This staged progression through the different levels represent and accumulation of knowledge and skills, which is why competencies are transferred from Level Three to Level Four. At the end of Level Four – and by implication the training programme – the registrar will be expected to have acquired and mastered all competencies stipulated in Level Four (including those transferred from previous levels). As such Level Four contains the exit-level outcomes.

Cells shaded in this colour indicate that this outcome (knowledge) is unique to Level Four, whereas cells shaded in white indicate those competencies and outcomes transferred from previous levels.

Cells shaded in this colour indicate that this competency/outcome (skill) is unique to Level Four, whereas cells shaded in white indicate those competencies and outcomes transferred from previous levels.

Table 6.4 Level Four radiology-specific learning outcomes [Table continues on next pages].

BREAST IMAGING		
KNOWLEDGE:	**A**	**B**
The anatomy of the breast:		
3) normal anatomy		
4) normal anatomical variants		
Age-related breast changes		
The physics of mammography image production and how it affects image quality		
Knowledge of the technical aspects of breast imaging:		
3) mechanism of obtaining and optimizing film-screen or digital mammograms		
4) adjustment of mammography techniques for special cases		
5) mechanism of obtaining and optimizing breast US		
6) mechanism of obtaining and optimizing breast MRI		
7) recognition, understanding, and correction of artefacts in breast		
8) imaging and workstation display of digital mammograms		
The respective roles (including indications and limitations) of the following imaging studies in terms of breast imaging:		
5) mammography		
6) tomosynthesis		
7) breast MRI		
8) breast ultrasound		
9) elastography		
10) PET CT		
11) sentinel node imaging		
12) ductography		
The principles and issues related to breast cancer screening		
BI-RADS (Breast Imaging Reporting and Data System)		
SKILLS:	**C**	**D**
Interpret mammograms diagnostically:		
1) recognize the normal anatomy on a mammogram		
2) discriminate between benign and malignant imaging findings		
Write clear, accurate and succinct reports using the BI-RADSystem		
Perform and interpret tomosynthesis		
Perform diagnostic ultrasounds of the breast:		
1) discriminate between solid and cystic masses		
2) recognise (typical and atypical) features of benign and malignant lesions		
Protocol and interpret breast MRI diagnostically		
Perform and interpret ductograms		
Perform ultrasound guided wire localisation		
Perform ultrasound guided FNAs of a breast lesion – solid or cystic		
Perform ultrasound guided core biopsy of a breast lesion		
Perform stereotactic biopsies		

Perform vacuum assisted breast biopsies		
Communicate malignant results to patients		
Discuss likely treatment of breast cancer with the patient		
Be able to discuss complex cases with referring clinicians and colleagues		
Assume a leadership role in multidisciplinary meetings		
CARDIAC IMAGING		
KNOWLEDGE:	**A**	**B**
Cardiac vascular anatomy:		
3) normal anatomy		
4) normal anatomical variants		
The respective roles (including indications and limitations) of the following imaging studies in terms of cardiac imaging:		
1) cardiac CT Angiography (includes heart and coronary imaging)		
2) MRI cardiac imaging (including viability studies)		
3) echocardiography		
4) nuclear cardiac studies		
SKILLS:	**C**	**D**
Interpret plain chest radiographs accurately and safely		
Perform and interpret ultrasound for pericardial effusion		
Protocol and interpret cardiac CT angiography and calcium scoring		
Protocol and interpret cardiac MRI studies (including viability studies)		
Interpret cardiac echocardiography		
Drain a pericardial effusion		
Write clear, accurate and succinct reports		
THORACIC IMAGING		
KNOWLEDGE:	**A**	**B**
Applied anatomy relevant to radiological diagnosis of thoracic disease		
3) normal anatomy		
4) normal anatomical variants		
Terminology relevant to thoracic imaging (Fleischner Glossary)		
The appearance and positioning of lines, tubes and devices		
Routinely performed thoracic surgical procedures		
Radiological appearances following common thoracic surgical procedures		
The management of the solitary pulmonary nodule (Fleischner guidelines)		
Imaging findings applicable to interstitial lung disease as identified on HRCT lung		
The respective roles (including indications and limitations) of the following imaging studies in terms of thoracic imaging:		
3) chest radiograph		
4) thoracic CT and CT Angiography		
5) DECT applications to thoracic imaging		
6) VQ scanning for pulmonary embolism assessment		
7) PET CT		
8) ultrasound		
9) MRI		
10) bronchoscopy		
The indications, contraindications, and complications of image guided lung biopsies (both fine needle and core)		
The indications, contraindications, and complications of guided pleural fluid drainage		
SKILLS:	**C**	**D**
Interpret plain chest radiographs accurately and safely		

Report a certain percentage (of a predetermined amount) of chest radiographs correctly in a specified amount of time		
Perform and interpret fluoroscopic diaphragm screening		
Protocol and interpret routine CT imaging studies relevant to thoracic imaging (including CT pulmonary angiography)		
Protocol and interpret HRCT of the lung		
Protocol and interpret MRI imaging studies relevant to thoracic imaging		
Interpret VQ scan for pulmonary embolism		
Interpret PET CT of the chest		
Perform image guided drainage of pleural effusions		
Perform image guided lung biopsies		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging modality for a given problem		
Assists in formulating an imaging and management plan as necessary		
GASTROINTESTINAL IMAGING		
KNOWLEDGE:	**A**	**B**
Normal anatomy of the:		
4) gastrointestinal tract		
5) hepatobiliary tract		
6) pancreas		
Normal variant anatomy of the:		
4) gastrointestinal tract		
5) hepatobiliary tract		
6) pancreas		
Radiological appearance of anatomically changes after common relevant surgical procedures		
Radiological appearance of the complications of common surgical procedures		
The respective roles (including indications and limitations) of the following imaging studies in terms of gastrointestinal imaging:		
5) barium/contrast screening studies		
6) ultrasound		
7) contrast enhanced ultrasound		
8) endoscopic ultrasound		
9) CT		
10) Dual Energy CT (as is applicable to gastrointestinal imaging)		
11) CT colonography (Virtual Colonoscopy)		
12) MRI/ (including MRCP)		
13) MR enterography and enteroclysis		
14) capsule endoscopy		
15) Percutaneous Transhepatic Cholangiogram (PTC)		
16) gastroscopy		
17) colonoscopy		
The principles, indications and limitations of the following nuclear medicine investigations in gastrointestinal imaging:		
1) nuclear medicine GIT bleeding studies		
2) Meckels scans		
3) Octreotide Scanning		
4) MIBG		
5) PET scan		

The indications, contraindications and complications of the following interventional procedures:		
1) percutaneous transhepatic cholangiography		
2) percutaneous transhepatic biliary stenting and drainage procedures		
3) radiofrequency (RF) ablation of liver lesions		
4) transarterial catheter-directed chemo embolization (TACE) of hepatic tumours		
5) percutaneous cholecystostomy		
6) transarterial catheter-directed diagnosis and treatment of gastrointestinal bleeding		
7) liver biopsies		
8) pancreas biopsies		
9) drainage procedures for intra-abdominal fluid collection and abscesses		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to GIT imaging		
Perform and interpret a range of relevant fluoroscopy studies		
5) barium swallow		
6) barium meal		
7) barium follow through / enteroclysis		
8) barium enema		
Perform and interpret an abdominal ultrasound for the assessment of abdominal viscera		
Interpret endoscopic ultrasound		
Protocol and interpret routine CT imaging studies relevant to GIT imaging		
Protocol and interpret CT colonography (VC) studies		
Protocol and interpret Dual Energy CT (DECT) applications to GIT imaging		
Protocol routine MRI imaging studies relevant to GIT imaging		
Protocol and interpret MR enterography and enteroclysis		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging modality for a given problem		
Perform ultrasound guide FNAs of liver lesions		
Perform ultrasound guided trucut biopsies of the liver and focal liver lesions		
Perform image guided ascites tap		
Perform image guided drainage of intra-abdominal fluid collections and abscesses		
Perform cholecystostomies		
Perform percutaneous transhepatic cholangiography (PTC)		
Perform percutaneous transhepatic biliary drainage procedures		
Perform percutaneous transhepatic biliary stenting procedures		
Perform transarterial catheter-directed diagnosis and treatment of gastrointestinal bleeding		
NEPHROLOGICAL AND UROLOGICAL IMAGING		
KNOWLEDGE:	**A**	**B**
Applied anatomy relevant to radiological diagnosis of urological imaging:		
3) normal anatomy		
4) normal variant anatomy		
The respective roles (including indications and limitations) of the following imaging studies in terms of urological imaging:		
4) ultrasound		
5) fluoroscopy		
6) CT (including CT urography)		
7) Dual Energy CT urological applications		

8) MRI (including prostate MRI)		
9) DTPA / DMSA / MAG III		
The indications, contraindications and complications of the following interventional procedures:		
1) imaging guided renal biopsies (trucut)		
2) percutaneous nephrostomy		
3) percutaneous nephrolithotomy (PCNL)		
4) transarterial catheter-directed renal embolisation		
5) tunnelled dialysis catheter placement		
6) AV fistula for dialysis		
Renal dialysis:		
3) indications		
4) various forms of dialysis		
5) complications associated with peritoneal dialysis		
6) imaging of AV fistula and complications of AV fistula		
Renal transplant:		
3) role of imaging in the workup to renal transplant - donor		
4) role of imaging in the workup to renal transplant - recipient		
5) imaging of complications following transplant		
6) follow up after transplant		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to urology and nephrology imaging		
Perform and interpret a range of fluoroscopy studies relevant to nephrology and urology:		
5) MCUG (micturating cystourethrogram)		
6) IVP (intravenous pyelogram)		
7) retrograde urethrogram		
8) cystogram		
Perform and interpret a range of ultrasound studies relevant to nephrology and urology:		
3) ultrasound of the urinary tract (kidney, ureters and bladder)		
4) vascular ultrasound of the kidney (including Doppler)		
5) ultrasound of transplanted kidney (including Doppler)		
6) scrotal ultrasound		
Protocol and interpret routine CT imaging studies relevant to nephrology and urology (including CT urography)		
Protocol and interpret routine MRI imaging studies relevant to nephrology and urology (including MRI prostate)		
Protocol and interpret Dual Energy CT applications to nephrology and urology imaging		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging modality for a given problem		
Perform percutaneous nephrostomies		
Perform image-guided renal biopsies (trucut)		
Perform transarterial catheter-directed renal embolisation		
Perform tunnelled dialysis catheter placement		
Perform AV fistula for dialysis		
GYNAECOLOGICAL IMAGING		
KNOWLEDGE:	**A**	**B**
Applied anatomy relevant to radiological diagnosis of gynaecological imaging:		

3) normal anatomy		
4) normal variant anatomy		
The respective roles (including indications and limitations) of the following imaging studies in terms of gynaecological imaging:		
6) transabdominal gynaecological ultrasound		
7) endovaginal gynaecological ultrasound		
8) hysterosalpingography (HSG)		
9) defecography		
10) abdomen and pelvis CT		
11) MRI pelvis		
12) MR defecography		
The indications, contraindications, complications of uterine artery embolization (UAE)		
Radiological follow up after uterine artery embolization (UAE)		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to gynaecological imaging		
Perform and interpret transabdominal pelvis (gynaecological) ultrasounds		
Perform and interpret hysterosalpingograms (HSG)		
Perform and interpret conventional defecograms		
Protocol and interpret routine CT imaging studies relevant to gynaecological imaging		
Protocol and interpret routine MRI imaging studies relevant to gynaecological imaging		
Protocol and interpret MR defecography		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging modality for a given problem		
Perform uterine artery embolism (UAE)		
OBSTETRIC IMAGING		
KNOWLEDGE:	**A**	**B**
The use of intravenous iodated contrast medium in a pregnant patient		
Imaging of a pregnant patient with suspected pulmonary embolism		
Imaging of a pregnant patient with acute abdominal pain		
Imaging of a pregnant patient with vaginal bleeding		
The role of different imaging modalities in pregnant patients:		
4) plain x-rays		
5) ultrasound		
6) CT		
7) MRI		
8) nuclear medicine		
SKILLS:	**C**	**D**
Advise on the most appropriate imaging modality for a given clinical problem in relation to a pregnant patient		
Perform transabdominal obstetric ultrasounds for confirmation of pregnancy and/or foetal viability		
Perform transabdominal first trimester obstetric ultrasounds		
Perform second or third trimester obstetric ultrasounds		
Perform endovaginal obstetric ultrasounds		
NEUROLOGICAL IMAGING		
KNOWLEDGE:	**A**	**B**
The applied anatomy relevant to spinal and cranial imaging:		
5) normal anatomy		
6) normal variant anatomy		

MRI physics		
MRI contrast media – indications, side effects and complications:		
Knowledge of the technical aspects and principles of MRI:		
21) magnets		
22) gradient coils		
23) RF coils		
24) functional MRI		
25) magnetic susceptibility		
26) nuclear magnetic moments		
27) effect of external magnetic field		
28) nuclear precession		
29) equilibrium magnetisation		
30) significance of radio frequency (RF) pulse		
31) resonance & Larmor frequency		
32) free induction decay (FID)		
33) chemical shift		
34) relaxation		
35) pulse sequences		
36) production of the image		
37) image quality		
38) hazards and bio-effects		
39) fat suppression and fat imaging		
40) magnetic resonance spectroscopy (MRS)		
41) contrast imaging		
42) flow effects		
43) hybrid MR-PET		
The respective roles (including indications and limitations) of the following imaging studies in terms of neuroimaging:		
7) CT		
8) CT Angiography		
9) CT brain perfusion imaging		
10) CT myelography		
11) CT cisternography		
12) neuronavigation imaging		
13) MRI		
14) MR Angiography		
15) MR diffusion imaging		
16) MR spectroscopy		
17) MR functional imaging		
18) conventional myelography		
19) catheter directed 4 or 6 vessel angiography		
20) spinal arteriography		
21) radionuclide cisternography		
SKILLS:	**C**	**D**
Interpret emergency radiographs of the skull and spine		
Perform and interpret image guided lumber punctures and myelography		
Interpret emergency CT imaging of the head and spine		
Protocol and interpret routine CT imaging relevant to neurological imaging including CTA		
Protocol and interpret a range of CT imaging studies relevant to neurological imaging:		

2) CT perfusion imaging		
3) CT myelography		
4) CT cisternography		
5) neuronavigation imaging		
Interpret emergency MRI imaging of the head and spine		
Protocol and interpret routine MR imaging relevant to neurological imaging including MRA		
Protocol and interpret a range of MR imaging studies relevant to neurological imaging:		
2) MR diffusion imaging		
3) MR spectroscopy		
4) MR functional imaging		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging modality for a given problem		
EXTRACRANIAL HEAD AND NECK IMAGING		
KNOWLEDGE:	**A**	**B**
The applied anatomy relevant to head and neck imaging:		
7) normal anatomy		
8) normal variant anatomy		
The respective roles (including indications and limitations) of the following imaging studies in terms of head and neck imaging:		
8) plain x-rays		
9) fluoroscopy studies		
10) video fluoroscopy (swallowing)		
11) sialography		
12) dacrocystography		
13) ultrasound		
14) CT and CT Angiography		
15) MRI		
16) MR sialography		
The management of thyroid nodules		
The role (principles, limitations and indications) of nuclear studies relevant to head and neck imaging		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to head and neck imaging		
Perform and interpret a range of fluoroscopy studies relevant to head and neck imaging including:		
1) video fluoroscopy (swallowing)		
2) sialography		
3) dacrocystography		
Perform and interpret ultrasound studies relevant to extracranial head and neck imaging excluding carotid ultrasound and ultrasound of the thyroid and parathyroids		
Perform and interpret ultrasound of the thyroid and parathyroids		
Protocol and interpret routine CT imaging studies relevant to extracranial head and neck imaging (including CTA)		
Protocol and interpret routine MRI imaging studies relevant to extracranial head and neck imaging (including MRA)		
Protocol and interpret MR sialography and dacrocystography		
Interpret nuclear studies relevant to head and neck imaging		
Perform ultrasound guided thyroid FNAs		

Perform ultrasound guided FNAs of neck nodes or masses		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging modality for a given problem		
MUSCULOSKELETAL IMAGING		
KNOWLEDGE:	**A**	**B**
The applied anatomy relevant to musculoskeletal imaging:		
3) normal anatomy		
4) normal variant anatomy		
Terminology relevant to musculoskeletal imaging		
The principles of bone and joint lesion characterisation		
The respective roles (including indications and limitations) of the following imaging studies in terms of musculoskeletal imaging:		
5) plain x-rays		
6) arthrography		
7) ultrasound		
8) CT		
9) MRI		
10) MR arthrography		
11) nuclear studies – bone scans and PET scans		
12) bone densitometry		
The post-surgical appearance of various common orthopaedic surgery procedures on follow-up imaging		
The radiological appearance of complications related to various common orthopaedic procedures		
Imaging of orthopaedic prostheses		
Rheumatology:		
1) the role of ultrasound in rheumatology		
2) the role of MRI in rheumatology		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to musculoskeletal imaging		
Interpret bone densitometry		
Perform image-guided arthrography - shoulder		
Perform and interpret musculoskeletal ultrasound of the		
1) shoulder		
2) wrist		
3) hand		
4) hip		
5) knee		
6) ankle		
7) soft tissue		
8) joints in the hands (rheumatology)		
Protocol and interpret routine CT imaging studies relevant to musculoskeletal imaging		
Protocol and interpret routine MRI imaging studies relevant to musculoskeletal imaging including MR arthrography		
Perform ultrasound guide fluid (joint) aspiration		
Perform image-guided bone biopsies		
Perform soft tissue biopsies		
Perform therapeutic joint injections		
Perform therapeutic soft tissue injections		

Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging for a given problem		
PAEDIATRIC IMAGING		
KNOWLEDGE:	**A**	**B**
The anatomy relevant to paediatric imaging:		
3) normal anatomy		
4) normal variant anatomy		
Age-related anatomical changes especially in		
5) urogenital imaging		
6) neuroimaging		
7) musculoskeletal imaging		
8) cardiac imaging		
Radiation safety dosimetry		
Dose reduction in relation to paediatric diagnostic imaging		
ALARA principles for modalities using ionizing radiation		
Practice-based imaging guidelines and appropriateness criteria (e.g. the ACR Appropriateness Criteria and Practice Guidelines)		
The respective roles (including indications and limitations) of the following imaging studies in terms of paediatric imaging:		
5) plain x-rays		
6) fluoroscopy studies		
7) ultrasound		
8) CT		
9) MRI		
The role (including principles, limitations and indications) of MIBG in paediatric imaging		
The role (including principles, limitations and indications) of Octreotide Scanning in paediatric imaging		
The role (including principles, limitations and indications) of PET Scans in paediatric imaging		
The role (including indications and limitations) of nuclear medicine GIT bleeding studies in paediatric imaging		
The role (including indications and limitations) DTPA / DMSA / MAG III in paediatric imaging		
The role (including indications and limitations) Meckels scans in paediatric imaging		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to paediatric imaging		
Perform and interpret a range of relevant ultrasound studies		
7) oesophagram		
8) tracheoesophageal fistula (TOF) study		
9) upper GI study with small bowel series		
10) barium enema (including anorectal malformation studies)		
11) reduction of intussusception		
12) micturating cysto-urethrogram (MCUG or VCUG)		
13) cystograms		
Perform and interpret a range of relevant ultrasound studies		
8) abdominal ultrasounds (including identification of intussusception, pyloric stenosis and appendicitis)		
9) renal ultrasound (renal, bladder and pelvis)		
10) transabdominal pelvis ultrasound		

11) hip ultrasound		
12) cranial ultrasound (neonatal head ultrasound)		
13) scrotal ultrasound		
14) ultrasound of the neck		
Protocol and interpret routine CT imaging studies relevant to paediatric imaging		
Protocol and interpret routine MRI imaging studies relevant to paediatric imaging		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging for a given problem		
Take a leading role in multidisciplinary paediatric meetings		
VASCULAR IMAGING		
KNOWLEDGE:	**A**	**B**
The vascular anatomy of all organs and peripheral circulation:		
3) normal anatomy		
4) normal variant anatomy		
The anatomy relevant to imaging examinations of:		
8) gastrointestinal tract		
9) trauma		
10) peripheral vascular disease		
11) cerebrovascular disease		
12) aorta		
13) dialysis access		
14) veins and vena cava		
Peripheral vascular disease including the role of imaging		
Peripheral vascular disease - the medical, surgical and interventional management options		
Aorta aneurysms:		
2) diagnostic imaging		
3) management		
4) endovascular repair		
5) follow-up imaging		
The respective roles (including indications and limitations) of the following imaging studies in terms of vascular imaging:		
6) plain x-rays		
7) ultrasound		
8) CT Angiography		
9) MR Angiography		
10) DSA catheter-directed angiography		
The role (including indications, contraindications, limitations and complications) of the various interventional procedures:		
1) percutaneous transluminal angioplasty (PTA)		
2) peripheral vascular stenting		
3) endovascular aneurysm repair of the aorta (EVAR)		
4) inferior vena cava filter placement		
5) vascular access		
6) placement of central lines		
7) embolotherapy		
8) catheter-directed thrombolysis		
SKILLS:	**C**	**D**
Interpret plain x-rays relevant to vascular disease		

Protocol and interpret CT Angiography (including aortagram and branches and peripheral arteriography of the limbs)		
Protocol and interpret MR Angiography (including aortagram and branches and peripheral arteriography of the limbs)		
Perform and interpret the following catheter-directed angiography:		
3) aortagram		
4) outflow of the lower limbs		
5) peripheral arteriography (including selective arteriography of upper and lower limb arteries, mesenteric arteries, renal arteries and pelvic arteries)		
6) arteriography of the aorta arch and neck vessels		
7) arteriography of the neck vessels		
8) cerebral 4 or 6 vessel cerebral arteriography		
9) venogram of the upper limbs		
10) venogram of the lower limbs		
11) venogram of the vena cava		
Perform and interpret vascular ultrasound:		
4) carotid ultrasound and Doppler		
5) ultrasound of the upper limb arteries		
6) ultrasound of the upper limb veins (including subclavian and axillary veins)		
7) ultrasound evaluation of abdominal aorta aneurysm		
8) ultrasound follow up of abdominal aorta aneurysm		
9) renal artery ultrasound and Doppler		
10) ultrasound of the lower limb arteries		
11) ultrasound of the lower limb veins for deep vein thrombosis		
Perform ultrasound guided insertion of central lines		
Perform the following interventional procedures:		
1) peripheral vascular percutaneous transluminal angioplasty		
2) peripheral vascular stenting		
3) renal artery angioplasty		
4) renal artery stenting		
5) inferior vena cava filter insertion		
6) catheter directed thrombolysis		
7) catheter-directed embolotherapy		
8) catheter-directed thrombolysis		
Write clear, accurate and succinct reports		
Be able to discuss complex cases with referring clinicians and colleagues		
Advise on the most appropriate imaging for a given problem		
Take a leading role in multidisciplinary vascular meetings		

The acquisition, development and mastery of all the requisite competencies – indicated as exit-level outcomes – will qualify the registrar for admission to the fellowship of the College of Radiologists of South Africa. The FC Rad Diag (South Africa) regulations for admission to the fellowship of the College of Radiologists of South Africa (CMSA 2013:17), stipulate that a candidate is expected to have comprehensive knowledge of:

- The role of various imaging techniques in the diagnosis of specific diseases.

- The imaging techniques currently available in South Africa to demonstrate both pathological and physiological processes.
- The equipment required to perform imaging techniques.
- The safe use of contrast media including the management and prevention of complications.
- The systematic examination, interpretation and oral and written communication of images together with a differential diagnosis and correlation of imaging findings.
- Physiological processes relating to physiological imaging.

The College of Radiologists of South Africa recognises that the radiologist forms part of a multi-disciplinary team and that the practice of radiology correlates intimately with the clinical management of the patient. The College (2013) consequently assert that a radiologist should be able to accurately interpret a clinical history, clinical examination and the findings of laboratory investigations. A radiologist should also hold a broad knowledge base of disease states, as well as the role of radiology in their diagnosis and management. Furthermore, a radiologist should have the ability to formulate logical approaches to clinical problems and be able to formulate a course of action that will benefit clinical knowledge, patient management and clinical outcomes. A radiologist should also provide a walk-in consulting and advisory services, inclusive of conducting scheduled clinical radiological meetings and discussions (CMSA 2013:17-18).

6.2.1.5 *Level Five*

Level Five represents a postgraduate level and as such has no curriculum. This level encompasses postgraduate education including (but not limited to) diplomas and fellowships in radiology as well as PhD studies in radiology.

6.3 NON-MEDICAL EXPERT COMPETENCIES IN POSTGRADUATE RADIOLOGY EDUCATION

The aim of the radiology postgraduate education and training programme is to develop a professional radiologist with a strong foundational knowledge, clinical competence and skills, necessary for effective practice as a radiologist and the continued development as a professional. In addition to the traditional medical expert role, the modern-day competent radiologist is expected to fulfil several additional non-medical roles, as part of being a complete physician. These physician roles have been described in the CanMEDS framework and adopted to radiology postgraduate curricula worldwide – in South Africa the CanMEDS educational framework has been adapted to undergraduate medical education within the South African context and described in the AfriMEDS document entitled *Core competencies for undergraduate students in clinical associate, dentistry and medical teaching and learning programmes in South Africa* (HPCSA 2014:2-14). However, at this point in time, no such document has been drafted for any postgraduate medical teaching and learning programmes in South Africa.

In the knowledge that the World Federation for Medical Education has acknowledged the importance of these medical roles in both pre- and postgraduate medical education, the researcher finds it appropriate and essential to include these roles and competencies into a curriculum for postgraduate radiology education and training at the UFS.

As the researcher could find no published adaptation of the CanMEDS roles to the College of Radiologists of SA context, he decided to use the revised and updated RANZCR Radiodiagnosis Curriculum as example of how these physician roles can apply to radiology.

6.3.1 Non-Medical Expert Roles Applied to Radiology

As part of the revision of their radiodiagnosis curriculum, the Royal Australian and New Zealand College of Radiologists adapted the seven original CanMEDS roles to diagnostic radiology in the RANZCR context. The following table not only depicts their efforts, but also provides clarity on how the different roles (skill sets) fits into the daily practice of a radiologist.

Table 6.5 The CanMEDS roles as adapted to RANZCR radiodiagnosis curriculum [Table continues on next page].

CANMEDS ROLE	RANZCR SKILL SET	COMPETENCY
Medical expert	Medical expert	Expert radiology knowledge Clinical decision-making skills Interventional expertise and judgement

Collaborator	Teamwork	Multi-disciplinary care
Communicator	Communication skills	Report writing expertise Presentation skills Patient communication and consent-taking
Health advocate	Patient support and advocacy	Appropriate use of medical imaging Radiation and electromagnetic safety Contrast agent safety
Professional	Professionalism	Ethical practice in radiology Patient confidentiality in imaging
Leader and manager	Management and administrative skills	Rostering and rotation planning Space and resource planning Purchase of new equipment
Scholar	Research and education	Continuing professional development Research skills and ethics Performing a literature search Appraisal of imaging literature Teaching and assessment of radiology Writing for publication and grant applications

The six non-medical expert roles should not be seen as mutually exclusive from the medical expert role, and as such should be incorporated into all aspects of the training programme.

The next few pages elaborate on each of the non-medical expert roles as described in the RANZCR Radiodiagnosis Curriculum (2009b:112-117). Following the introduction of each competency, the key competencies relevant to that skill set are listed. There are also examples of learning activities that may contribute to the acquisition of these competencies.

The researcher emphasises that – with the necessary consent – these roles and their key competencies should be adapted to the South African context and incorporated into the curriculum for postgraduate radiology education and training.

6.3.1.1 *Teamwork*

Radiologists establish and maintain cooperative relationships with patients, with radiology staff and with other clinicians to optimise patient care and to facilitate research and education.

At the end of their training, radiology registrars are able to develop their role in the provision of patient care and the expectations of the patient and clinician requesting imaging, demonstrate knowledge and communication of the strengths and limitations of the resources available for patient care including equipment, personnel, infrastructure, time constraints and cost, manage working relationships effectively and professionally, and facilitate research and education.

These capabilities may be gained through learning activities such as:

- Reflective practice as a trainee.
- Observation of the behaviour of senior radiologists and departmental staff.
- Discussion with senior staff and peers.
- Formal feedback in appraisal sessions.
- Liaison with referring practitioners.
- Participation in conferences, inter-disciplinary meetings and continuing education.
- Education in conflict management.

6.3.1.2 *Communication Skills*

Radiologists recognise the importance of communication in best practice of medicine. They acknowledge the vital role of good communication skills in all of their extended roles.

At the end of their training radiology registrars are able to demonstrate good communication skills, participate in activities using feedback to ensure good communication and continually develop their skills, communicate effectively across different settings, and demonstrate the ability to recognise difficult communication situations and to work within these situations to achieve the best possible outcome.

These capabilities may be gained through learning activities such as:

- Observation of the behaviour of senior staff with discussion of this behaviour.
- Formal feedback in appraisal sessions.
- Observation of departmental staff.
- Liaison with referring practitioners.
- Participation in conferences/ inter-disciplinary meetings/ continuing education.
- Attendance at communication skills workshops.
- Discussion of conflict management or training in conflict management.

6.3.1.3 *Patient Support and Advocacy*

As health advocates, radiologists responsibly use their expertise and influence to advance the health and well-being of individual patients, communities and populations. Their knowledge of the risks and costs of imaging procedures are balanced against the benefits to individual patients and the community. Advocacy may occur individually or as a group when influencing public health policy.

At the end of their training, radiology registrars are able to advocate for individual patients, advocate for the profession and advocate for trainees.

These capabilities may be gained through learning activities such as:

- Discussions with senior staff about health system issues.
- Observation of more senior trainees and radiologists in their tasks.
- Involvement in department planning activities.
- Conduct of patient surveys.
- Activities within local branch of the College.
- Participating in multidisciplinary staff meetings.
- Participating in change management process in department.
- Public speaking to community groups.
- Review relevant sections of the National Patient Safety Education Framework.

6.3.1.4 *Management and Administrative Skills*

Radiologists make decisions regarding effective utilisation of finite health care resources in the context of individual patient care. They provide leadership in healthcare organisations and ensure effective work practices through adequate staffing and development of policies and procedures.

At the end of their training radiology registrars are able to participate in activities that contribute to the effectiveness of healthcare organisations and systems, and manage their practice and career effectively.

These capabilities may be gained through learning activities such as:

- Regular supervisor review.
- Review of outstanding reports.
- Observation of senior staff.
- Formal instruction in daily team activities.
- Instruction such as workshops on teamwork and roles.
- Studying Management courses.
- Progressive responsibility for conduct and reporting of studies.
- Time management workshops.
- Discussion of budgeting and costs with senior staff.
- Career mentorship.
- Participation in departmental audit activities.
- Career information from professional body website.
- Participation in research projects.

6.3.1.5 ***Professionalism***

Radiologists aim to deliver the best possible quality of health care with integrity, honesty and compassion. Radiologists exhibit high standards of personal and interpersonal behaviour and they practice ethically with active concern for the patient, their profession and society.

At the end of their training radiology registrars are able to behave ethically, give priority to patient care and to continuity of care, behave appropriately towards patients and colleagues and support accountability and the development of the profession.

These capabilities may be gained through learning activities such as:

- Study or review of ethical and professional codes of practice of the College, Medical Boards and other bodies.
- Observation of others performing at a high standard.
- Discussion of the trainee's own practice and any issues they may have experienced or wish to explore with their supervisor.
- Feedback from supervisors.
- Negotiating a learning contract with a supervisor concerning performance in the area of professionalism.
- Developing a portfolio of cases or situations illustrating professional issues.
- Participating in cultural awareness training.
- Preparing a service profile for the department and compare this with the surrounding community, or levels of service generally by radiology.
- Writing up reflective commentary of critical incidents or cases where an ethical or professional issue emerged.
- Taking a course relating to ethics in medicine and/or radiology.
- Review legal aspects of medical litigation related to radiology and membership of a MDT.
- Document incidents that may have medico-legal implications and notify and discuss these incidents with their supervisor or a senior colleague.

6.3.1.6 *Research and Education*

Radiologists recognise the importance of participating in and encouraging life-long learning. They contribute to the appraisal, collection, dissemination and comprehension of healthcare knowledge. They assist and promote the education of clinical colleagues, other healthcare providers, students, patients, the community and other bodies. Radiologists recognise the importance of research and actively participate in advancing the knowledge of their speciality.

At the end of their training, radiology registrars are able to adopt a scholarly approach to practice, apply the principles of evidence-based medicine, develop educational skills and techniques and develop research skills.

These capabilities may be gained through learning activities such as:

- Presentation at scientific meetings.
- Presentation at departmental meetings.
- Preparation of grant applications in collaboration with senior colleagues.
- Publication of peer-reviewed papers.
- Submission of posters or papers to conferences.
- Statistical skills courses.
- Critical appraisal courses.
- Journal clubs.

6.3.1.7 *Non-Medical Key Competencies*

As part of the Delphi survey, respondents were asked to indicate which key competencies registrars had to integrate into their postgraduate radiology training that would allow competence in the different core competencies/non-medical physician roles (*cf.* 6.3.1.1 – 6.3.1.6). In addition, respondents were asked to indicate on which of these competencies registrars should receive formal tuition. Table 6.6 provides a summary of the results from the survey.

Category A indicates an in-depth *knowledge of* the subject whilst Category B indicates a basic *knowledge about* the topic.

Cells shaded in this colour indicate that registrars should receive formal tuition on this topic.

Table 6.6 Non-radiological key competencies [Table continues on next page].

	A	B
Research principles		■
Best practice in research		■
The concept of medical professionalism	■	
The role and interaction of the relevant professional bodies		■
The principles of good communication	■	
Conflict resolution techniques	■	
The procedure of consenting procedures	■	
Child protection legislation		■
Discrimination		■
The basic rights of patients	■	
Constructing meaningful reports	■	
Organisational skills		■
Time management		■
Delegation skills		■

The use of sedation (both in adults and children)		
The use of analgesia (both in adults and children)		
Breaking bad news		
The action required in case of a needle stick injury		
Infection control		
The appropriate use of personal protection equipment		
Media awareness and public communications		
Principles of medical ethics		
Patient confidentiality		
Communicable disease notification		
The principles of evidence-based medicine		
The critical appraisal of evidence and articles		
The use of computer technology in modern day radiology		

6.4 ASSESSING COMPETENCE IN POSTGRADUATE RADIOLOGY EDUCATION

Hibbert, van Deven and Ros (2012:13) remind us that assessments are methods of gathering information and making judgements about knowledge and performance; by its very nature an assessment should therefore be representative, valid and reliable, as well as appropriate and relevant. This identification of a candidate's level of performance and knowledge (the answer to the question *Where am I now?*) allows comparisons with expected levels of performance and knowledge, as well as with that his or her peers (the answer to the question *Where do I need to be?*). Answering the question *How do I get from where I am to where I need to be?* has the ability to guide and modify the candidate's future learning and managed correctly, will allow the candidate to reach or exceed expected levels of performance and knowledge (Atkin, Black and Coffey (2001) in Hibbert *et al.* 2012:13).

From a theoretical perspective assessment can be summative or formative; objective or subjective; formal or informal; and centralised or decentralised (Gunderman 2012:50-54). An elucidation of these terms follows.

Summative assessment takes place – for the most part – at the conclusion of a defined instructional period and is used to assess learning, skill acquisition and academic achievement. The results of summative forms of assessment are usually expressed as scores or grades, which are recorded and become part of the student's permanent academic record: these scores and grades often influence decisions about academic progression or a student's eligibility to sit an exit or final examination. As such, summative assessments are viewed as high stakes assessments that demand accuracy, and therefore, reliability. Consequently, these forms of assessments are mostly standardised and the students' compared to a defined standard appropriate to their level of training or stage of education.

The focus of formative assessment is on helping learners improve, and it does so by informing the learning and instruction processes. This form of assessment takes place frequently during the instructional period and through the process of feedback and remediation aims to enhance learning. A good example of formative assessment is workplace-based assessments: here the student is assessed whilst performing a task in a normal working environment, followed by feedback regarding his or her performance and a discussion about how to improve on inadequacies identified during the assessment. Performances can be graded during formative assessments but this is not the primary function of this form of assessment. The continuous postgraduate radiology assessment programme proposed here includes summative assessments, but focuses primarily on formative assessment and workplace-based assessments.

Objective assessments rely on only one correct answer or response – with subjective assessment there is a spectrum of more or less correct possibilities or responses (Gunderman 2012:50). In the opinion of the researcher, there is place for both in postgraduate radiology assessment.

Informal assessments are based on impromptu interaction with the registrar during their daily practice. Unlike formal assessments, these assessments do not involve the use of standardised assessment instruments, such as a standard assessment form that makes use of a rating scale or standardised scoring system and is used to assess all students. Both forms of assessment have a role to play in postgraduate radiology and used formatively, both can contribute considerably to student learning. Whereas formal assessments may be more time consuming, the documentation of performance is an essential contribution to the body of evidence about an individual student's progress and performance at various stages of his or her training.

Centralised and decentralised refers simply to the difference between a central disconnected body prescribing to departments which assessments should take place, when and how they should be conducted and what they should assess as opposed to an approach that allows each department to do what works best for their context. Gunderman (2012:54) recommends a balance between centralised and decentralised approaches – the researcher agrees and argues that certain recommendations regarding assessment should guide each department in constructing an assessment programme that is feasible within their context.

6.4.1 General Principles Concerning Continuous Assessment as part of Postgraduate Radiology Training at the UFS

Formative assessment – in the form of workplace-based assessments – should form the backbone of the assessment programme. Most of these assessments will be conducted informally during observation of the registrars' daily practice. A fraction of the formative assessments will, however, have to be conducted formally – for this the assessor will use a standardised assessment form designed for that specific type of assessment (*cf.* Appendix C1 - C4 for examples of these assessment forms). The performance of the registrar should be judged according to the criteria stipulated on the assessment form. The assessor should, furthermore, judge the performance of the registrar at a level appropriate for his or her level of training and experience. No scores are given but a simple three or four category grading system should apply. According to this, the performance of the registrar, observed by the assessor during the assessment, can be graded as *unsatisfactory* or *satisfactory* – with or without recognition of above par performances.

Immediately after completion of a formal assessment, the assessor should provide the registrar with constructive feedback about his or her performance during the assessment. Positives should be highlighted and weaknesses or inadequacies discussed. Where inadequacies have been identified during the assessment, the assessor is expected to make suggestions or provide guidance that will assist the registrar in addressing these inadequacies. In the event of an unsatisfactory formal assessment, the assessment will have to be repeated at a future date. The registrar should be allowed enough time to improve his or her performance. During this remedial period, the registrar may be reassigned to a rotation or assigned an appropriate mentor (preferably of his or her choice).

The subject of the assessment should be dictated by the registrar's level of training (*cf.* the curricula for the different levels of training).

Figure 6.1 An adaptation of Miller's triangle of clinical competence (adapted from Zaidi and Nasir 2015:114).

KNOWLEDGE SKILLS ATTITUDE	EXPERT	**DOES**	Performance integrated into practice	Behaviour
	↑	**SHOWS**	Demonstration of learning	
		KNOW HOW	Interpretation and Application	Cognition
	NOVICE	**KNOWS**	Fact gathering	

The level of competence should be judged in each assessment, regardless of the activity being assessed or the type of assessment. Successful completion of an assessment requires demonstration of the required behaviour, skills and knowledge integrated into daily practice and observed during the performance of the task – being assessed – in a normal working environment. Figure 6.1 shows the levels of clinical competence involved in the process of developing competence.

Registrars should not be allowed to choose their assessor. Concerning the formal Mini-IPX and Rad-DOPS assessments: the consultant overseeing the modality where the assessment is conducted is responsible for that assessment during the Level Three instructional period. During the Level Four instructional period, the consultant responsible for a specific organ-based sub-specialty will conduct all assessments pertaining to that rotation. At the UFS Clinical Imaging Science (radiology) Department, specific consultants oversee specific modalities, as well as take responsibility for specific sub-speciality training according to their areas of interest and expertise. The researcher, for example, oversees CT and ultrasound and is responsible for chest, cardiovascular and abdominal imaging and related diagnostic interventional procedures. During Level Three rotations, he will be responsible for all CT and ultrasound assessments and during Level Four rotations he will conduct all assessments related to chest/ cardiovascular and abdominal imaging. This consistency allows consultants to own an assessment, develop and improve it and benchmark assessments.

Concerning the formal Mini-IPX and Rad-DOPS assessments: assessments during the Level Three instructional period are modality based, whereas assessments during the

Level Four instructional period are dictated by the organ-based sub-specialty rotation. The use of either IPX or DOPS will depend on the rotation and the available opportunities. The formal assessment can be performed at any time during the month as long as it is completed by the end of the month rotation.

Concerning the Radiological Direct Observation of Procedures, the researcher recommends the assessment of a set of prerequisite critical cross-field abilities. These procedural skills are not necessarily organ or modality dependent but represent procedural skills that can be used across various diagnostic and therapeutic procedures. As this concept was identified only during the last of the semi-structured interviews, the researcher did not have the opportunity to research the content of such a list of critical cross-field abilities. It is therefore left to the relevant assessors to identify and define the critical cross-field procedural skills applicable to the domain within which they assess. Suggestions for these critical cross-field procedural skills include (but are not limited to):

- The free-handed technique for ultrasound-guided placement of a needle as used in the fine needle aspiration of a lesion.
- The Seldinger technique used to obtain access to blood vessels and hollow organs.
- The image-guided placement of percutaneous drainage catheters for the purpose of draining abscesses and fluid collections.
- The ability to perform an abdominal ultrasound correctly and accurately.
- The principles and technique involved in basic cardiopulmonary resuscitation (CPR).

Concerning Teaching Observations and Multidisciplinary Teamwork assessments: the consultant responsible for overseeing the academic or interdisciplinary meeting should observe the registrar's performance during the meeting and complete the assessment during the meeting. At the end of the meeting the assessor should provide the registrar with formative and constructive feedback. As registrars are responsible for their own two assessments per year, a registrar may approach an assessor to schedule a formal TO or MDT assessment.

Concerning Multisource Feedback: the RCR recommends, that to make the feedback worthwhile, at least ten assessors should complete and return the MSF forms. Registrars should choose a range of assessors relevant to their work situation. The assessors should be chosen from (not more than two assessors per category):

- consultant (radiologist);
- consultant (other than radiologist);
- radiographer;
- sonographer;
- nursing staff;
- administrative, clerical or secretarial staff;
- registrars (radiology); or
- registrars (other than radiology).

The registrar must also complete a self-assessment. Once the MSF responses have been summarised, a copy of the summary should go to both registrar and the programme director/ Head of Department. The registrars should be given feedback – preferably by someone who has been trained to give MSF feedback. Ideally, registrars should also reflect on the results of the MSF and attempt to make the relevant changes to the way they practice.

Assessment forms are designed to guide the assessment. The use of standardised assessment forms endeavour to minimise subjectivity and ensure a uniform and consistent assessment across the board. The forms specify the areas that need to be assessed and describe the scale used to judge a performance. There is also an area for comments about the observed performance – in specific comments about identified inadequacies and weaknesses (which should be documented). The assessor should also document any decisions taken to improve on identified weaknesses and inadequacies, and finally, the assessment document is signed by both the registrar and the assessor. This enables the assessment to be used as an official documentation of performance at a given point during the candidate's training period. It also enables reflection on previous performances to ensure that registrars improve on identified weaknesses and inadequacies.

It will benefit the assessment programme if assessors are informed of the basic educational concepts concerning assessment and performance (outcome and competency) based education – the registrars could (and probably should) also be informed of these concepts and principles.

6.4.2 Formative Workplace-Based Assessment as part of the Postgraduate Radiology Training at the UFS

The following formal workplace-based assessments ***should*** be included in the postgraduate radiology assessment programme:

Mini-IPX – used in the assessment of integrated interpretive and diagnostic knowledge and skills, as well as communication skills, professionalism, management and administrative skills, patient support and advocacy.

Rad-DOPS – used in the assessment of procedural knowledge and skills, as well as communication skills, professionalism, patient support and advocacy, management and administrative skills.

Multisource feedback (MSF) – used in the assessment of non-medical expert roles and generic competencies such as communication, teamwork, professionalism, management and administrative skills, as well as patient support and advocacy.

Review of dictation – this is not so much an assessment as it is a formative exercise aimed at improving a registrar's ability of compiling accurate and meaningful reports.

The following formal workplace-based assessments ***could*** be included in the postgraduate radiology assessment programme:

Teaching Observation – used in the assessment of knowledge, communication skills, and research and education skills

Multidisciplinary Teamwork Assessment – used in the assessment of knowledge, professionalism, communication skills, patient support and advocacy skills.

One formal Rad-DOPS or Mini-IPX assessment should be completed during each monthly rotation with a minimum of ten per year, for every year of the training programme. The type of assessment will depend on the rotation (modality) and opportunities on offer during the rotation.

A Multisource Feedback assessment – including a self-assessment – should be concluded at least once during the Level Three instructional period (for example during the second year of a registrar's training programme) and once during the Level Four instructional period (for example during the fourth year of a registrar's training programme). These assessments are not subject to grading or scoring, but serve to identify weaknesses in behaviour that should be addressed.

This thesis does not prescribe a requisite number of formal Teaching Observation (TO) and Multidisciplinary Teamwork assessments, but recommends a minimum of two formal TO per year for the duration of the training programme and two formal MDT assessments per year once the registrar starts taking responsibility for scheduled interdepartmental meetings.

The review of dictation should be done once a year, starting in the second year of training. The number of reports to be reviewed should be decided by the programme director in combination with the Head of Department. Once a registrar has critically reviewed his or her reports from the year before, his or her conclusions should be discussed with the programme director or Head of Department.

Random informal workplace-based assessments (either mini-IPX or rad-DOPS) should also be undertaken during the monthly rotations. These will however not be subject to grading but instead serve a mostly formative purpose. As such these assessments should lead to constructive and formative feedback, which is aimed at directing the registrar's future learning.

6.4.3 Assessments According to the Different Levels of Training

This section describes the different formative and or summative assessments relevant to each training level. The assessment tools for each level were chosen by the researcher, based on personal experience, discussions with his promoters and data from the research (including the literature overview and the semi-structured interviews).

6.4.3.1 *Level Two*

At the end of the Level Two instructional period the registrar will be assessed for independent on-call readiness. A panel of consultant (qualified) radiologists from the department will perform the assessment, which will take the form of an image-based OSCA (Objective Structured Clinical Assessment).

The OSCA may assess on the imaging findings (plain X-ray, fluoroscopy, ultrasound and CT) of any or all disease stipulated in the Level Two curriculum. The candidate may also be assessed on a basic understanding of the imaging application of different imaging modalities such as plain X-rays, fluoroscopy, ultrasound and CT – the notable exceptions being mammography and MRI (at this level requests for MRI studies should be directed at the consultant on-call).

The assessment should be followed by a formal and constructive feedback session, including recommendations for further learning.

In the event of an unsatisfactory assessment, the registrar should be allowed to repeat the assessment after a period of one month. Should the registrar fail to pass the second assessment he or she may be ejected from the training programme at the discretion of the Head of the Radiology Department.

Formal and informal workplace-based assessments undertaken during the Level Two instructional period should form part of the assessment for on-call readiness. Recommended workplace-based assessments include Rad-DOPS and Mini-IPX assessments. The supervising consultant responsible for the activity should undertake these workplace-based assessments. All forms of workplace-based assessment have to include constructive, formative feedback and recommendations for improvement – these comments have to be made immediately following the assessment. Where necessary (for example an unsatisfactory assessment), a follow-up assessment should be scheduled for a time acceptable to both candidate and assessor.

6.4.3.2 *Level Three*

At the end of the Level Three instructional period – a period of thirty months from the start of the training period – the registrar will be required to pass a mandatory summative intermediary examination (UFS only) in order to advance to the Level Four instructional/training period. The subjects included in the examination are FFM700 Physiology (Medicine), PATR7900 Pathology and RADP7900 General Radiology Principles (UFS 2014:44).

The examination will take the form of a written paper and an image-based OSCA. The OSCA will include different imaging modalities namely plain X-rays, fluoroscopy, ultrasound and CT – notable exceptions are mammography and MRI (at this level registrars are not expected to independently interpret and report mammogram and MRI studies). Due to the summative nature of this examination formal feedback is not mandatory.

In the event of the candidate failing the examination, the registrar should be allowed to repeat the assessment after a period of six months. Should the registrar fail to pass the second examination, the Head of the Department will have the option to eject the registrar from the training programme. The documented formative assessments of the previous thirty months can additionally inform and influence this far-reaching decision.

During the Level Three instructional period, the registrar will also undergo regular formal workplace-based assessments. Each monthly (modality-based) rotation will qualify for a formal workplace-based assessment – either a Mini-IPX or a Rad-DOPS – and at least ten of these formal assessments will have to be completed successfully each year. The supervising consultant responsible for the rotation is also responsible for that particular formative assessment. The registrar may be assessed on any of the outcomes from the Level Three curriculum. Assessments will judge the registrar's knowledge, skills and behaviour/attitudes (where applicable). The registrar's performance will be judged according to the criteria contained within the applicable standardised assessment form (*cf.* Appendix C1 – C4) and at a level appropriate for the candidate's level of training. All forms of workplace-based assessment have to include constructive, formative feedback and recommendations for improvement – these comments have to be made immediately following the assessment. In the event of an unsatisfactory assessment, a follow-up assessment should be scheduled to allow the registrar time to improve his or her performance.

At least one Multisource Feedback assessment and self-assessment should be conducted during this period.

Informal workplace-based assessments may also be undertaken during the monthly rotations – these will, however, not be subject to grading but instead serve a mostly formative purpose. As such these assessments will lead to constructive and formative feedback, which is aimed at improving learning.

At the end of each quarter, all registrars across the board, irrespective of experience or level or training, will undergo the same quarterly summative assessment. This quarterly assessment will consist of written questions, an image-based rapid reporting session and an image-based long case. This assessment examines at graduate level and is consequently based on graduate (exit-) level outcomes. The scores from these quarterly assessments will contribute to the registrars' year mark.

An ideal addition to the quarterly assessment is a *radiology progress test*, similar to the Dutch Radiology Progress Test (*cf.* 2.2.3.4). The progress test is not an examination that has to be passed: instead it provides feedback about academic progress, to both the registrar and the programme director (*i.e.* it has a purely formative function). The test usually consists of a combination of theoretical short questions and image-based short questions. The difficulty of the test is aimed at exit-level outcomes and as such *on par* with the radiology final examination – this allows registrars to compare their performance to that expected of them at graduate level. According to one of the interviewees from the semi-structured interviews, question banks containing short questions for use in the progress tests are available internationally and licenses for use can be obtained by the RSSA and passed on to radiology departments.

6.4.3.3 *Level Four*

During the Level Four rotation, the registrar will again undergo regular workplace-based assessments. Each organ-based rotation will qualify for a formal workplace-based assessment that will comprise either a Rad-DOPS or a Mini-IPX assessment.

The consultant responsible for the sub-specialty rotation is responsible for that particular workplace-based assessment. The registrar may be assessed on any of the outcomes within the Level Four curriculum, appropriate to the specific sub-specialty. Assessments will examine the registrar's knowledge, skills and behaviour (where applicable) and the registrar's performance will be judged according to the criteria contained within the applicable standardised assessment form (*cf.* C1 – C4). The registrar will again be assessed according to his or her level of training. The assessor has to provide constructive and formative feedback (including recommendations on how to improve) immediately following the assessment. Unsatisfactory assessments have to be repeated.

Further workplace-based assessments such as Teaching Observations, Multisource feedback and Multidisciplinary Teamwork assessments will continue to assess the non-medical competencies such as communication, professionalism, teamwork etc.

The annual review of dictation will continue to contribute to the registrar's report dictation skills.

Informal formative assessments made during daily practice will not be documented, but should ideally lead to formative feedback and improved learning.

Registrars at this level will also be eligible for the mandatory summative quarterly assessments.

During the Level Four instructional period, but not earlier than four years into the postgraduate training period, according to the rules of the College, a registrar is eligible to sit the College Part II Final Examination. Eligibility and readiness to sit the final examination should ideally rest with the consultant body of the department and should be determined by a body of evidence informed by a range of workplace-based formative assessments documented during the foregoing four years of training. A formalised mock examination (involving examiners and private radiologists from outside the department) may also contribute to the final decision about readiness for the final examination.

6.5 SUMMATIVE DISCUSSION

The proposed assessment programme consists of continuous formative workplace-based assessments and scheduled summative assessments and examinations.

The Mini-IPX and Rad-DOPS assessments make up the backbone of the continuous assessment programme. Most of the IPX and DOPS assessment will be unscheduled and informal, conducted by way of casual observation and through discussion with the registrars during performance of their daily duties in the workplace. At least one formal IPX or DOPS assessment has to be completed per month with a prescribed minimum of ten per year (allowing for vacations, allotted research time and rotational stand-in duties). Assessments will be conducted by the consultant overseeing the modality and responsible for the sub-specialty rotation. All formative assessments should culminate in constructive feedback and remedial action where necessary. Multisource Feedback assessments should be conducted twice – once during the Level Three instructional period and once during the Level Four instructional period. Each time the registrar will also have to complete a self-assessment. Both Teaching Observations and Multidisciplinary Teamwork assessments should be conducted twice a year – only applicable once registrars start taking the lead at academic and interdisciplinary meetings. The review of reports is scheduled for once a year, commencing during the second year of training.

The scheduled summative assessments include the regular quarterly assessments, an OSCA at end of the Level Two instructional period and an intermediary examination at end of Level Three instructional period.

In summary, the purpose of this assessment schedule is to:

- identify inadequacies and weaknesses in a registrar's performance at an early stage;
- improve and direct a registrar's learning and training through formative and constructive feedback;
- introduce remedial action whereby a student can improve on the identified inadequacies and weaknesses;
- guide a registrar through the five-year curriculum;
- document a student's progress and academic achievement;
- ensure the attainment of the prerequisite outcomes and competencies;
- accurately and timeously – with the necessary documentation – identify the candidate who should not be allowed to continue his or her training in postgraduate radiology (preventing the waste of time and money);
- ensure a competent and complete product at the end of the training period; and
- provide a transparent and auditable process.

6.6 CONCLUSION

Chapter 6 combined the results, deductions and conclusions from the empirical research undertaken during by the researcher, with information garnered from the literature and the views and opinions of the researcher, to propose both a set of curriculum outcomes and assessment methods for revision of post-graduate radiology training at the UFS.

Most of the aspects relating to the proposed curriculum outcomes and structure, as well as the continuous assessment of the registrars during post-graduate radiology training, were based on the outcomes of the empirical research (*cf.* Chapters 4 and 5) and include:

- the integration of generic physician roles and competencies – such as those defined by the RANZCR (based on the CanMEDS framework) – into the curriculum;
- merging sets of competencies (knowledge and skills) according to particular levels of training;
- the implementation of a structured assessment programme dependent on a range of different workplace-based assessment tools;
- regular workplace-based assessments, conducted formally and documented;
- frequent informal formative assessments as part of the day-to-day activities within the radiology department, not documented;
- constructive feedback after each formative assessment – albeit formal and casual;
- the documentation of feedback and any planned remedial action following formal assessments;

Other recommendations, such as the compartmentalisation of the curriculum according to levels of increasing difficulty and integration (referred to as *levels of training* or *instructional periods*); the proposed theoretical knowledge of the Level Two instructional period; the inclusion of a qualifying summative assessment (at the end of the Level Two instructional period) prior to independent after-hours radiology call; and the inclusion of a mandatory intermediate summative examination halfway through the training period (at the end of the Level Three instructional period) are based on information garnered from the literature and wider discussions and experiences not reported in this thesis.

The different levels of training were conceived during initial discussions with the promoter (although levels were already introduced during the Delphi survey). The introduction of a Level Two training, as well as the proposed syllabus for this level, emanated from discussions with the Head of Department, Clinical Imaging Sciences, UFS

In the next chapter, Chapter 7, **Conclusions, Limitations and Recommendations of the Study**, a summative discussion, limitations of the study, conclusion and recommendations from the study will be provided.

CHAPTER 7

CONCLUSION, LIMITATIONS AND RECOMMENDATIONS OF THE STUDY

7.1 INTRODUCTION

The training of a competent, self-regulating graduate depends on a curriculum that encompasses all the necessary knowledge, skills and behaviour inherent in the radiology profession. An integrated formative assessment programme, blueprinted on the curriculum, can go a long way towards ensuring the acquisition and mastery of all the competencies required to function as a safe, effective and professional specialist radiologist. Academic institutions are responsible for the quality of their graduates, and in an era of accountability and transparency, it is appropriate that academic departments are able to elucidate and justify their education and training programmes. Furthermore, in order to produce graduates of an international quality, curricula need to accommodate the essential competencies and educational principles demanded by international standards.

Based on this premise, the researcher undertook an in-depth study with a view to developing a formative, performance-based, continuous assessment programme, in addition to reviewing and updating the radiodiagnosis curriculum, for postgraduate radiology training at the University of the Free State (UFS).

The chapter provides a short overview of the study and presents comments and concluding thoughts on the findings. The chapter commences with an overview of the study, followed by recommendations for revision of the radiodiagnosis curriculum and development of the continuous assessment programme; conclusions; a short discussion on the limitations of the study; a reflection on the contribution to knowledge; an elucidation of the significance and contribution of the research; recommendations and final conclusive remarks.

7.2 OVERVIEW OF THE STUDY

The findings of the research served as foundation for the design of a continuous performance-based assessment programme for postgraduate training at the UFS and review of the radiodiagnosis curriculum.

The research was carried out based on three research questions.

7.2.1 Research Question One

The research question was stated as:

How to contextualise and conceptualise postgraduate radiology education?

The following objective was pursued:

The contextualisation and conceptualisation of radiology education and training, both internationally and in South Africa.

In order to address the issue of postgraduate radiology education, the researcher had to familiarise himself with relevant key educational concepts. A literature overview informed the conceptualisation of outcome- and competence-based education (2.2.1.2), and the concept of competence (2.2.1.1) – including the all-important CanMEDS educational framework. A review of recent changes to radiodiagnosis curricula of the United State of America (2.2.2.1), the United Kingdom (2.2.2.2), and New Zealand and Australia (2.2.2.3) allowed the contextualisation of a modern-day curriculum for postgraduate radiology education – essential in addressing the curriculum in a South African context.

Developing a continuous competency-based assessment programme as part of a postgraduate radiology training programme in the context of South Africa required an understanding of basic concepts underpinning assessment in postgraduate radiology. Again, a literature overview informed the conceptualisation of assessment in education, including the concepts of formative assessment and summative assessment (2.2.3.1), workplace-based assessment (2.2.3.2), portfolios (2.2.3.3) and the progress test (2.2.3.4).

Chapter 3 provides a detailed description of the literature overview and its application in this research study (3.2.1).

Chapter 2 brings together relevant information from the literature overview, which provides the reader with insight into the researcher's theoretical framework on which the actual research was based.

The accomplishment of this objective addressed research question One.

7.2.2 Research Question Two

The research question was stated as:

How to revise the curriculum for postgraduate radiology training at the UFS?

The following objective was pursued:

A revision of the UFS postgraduate radiology curriculum, defining learning objectives and formulating outcomes, incorporating all required competencies.

To address this research question, the researcher employed the Delphi questionnaire survey to collect expert opinions – about the content of a postgraduate radiology curriculum in the context of South Africa – from pivotal role-players involved in postgraduate radiology education. In search of comprehensive views and opinions, the Delphi panel also included experienced radiologists employed in private practice, and a prominent South African academic radiologist with many years of experience in the international academic environment.

Chapter 3 describes the theoretical aspects of the Delphi questionnaire survey (3.2.2.1) before focussing on the Delphi process and questionnaire in this study (3.2.2.2) – this discourse includes a description of the target population (3.2.2.3), the survey population (3.2.2.4), the sample size (3.2.2.5) and the sample (3.2.2.6) – the latter section also describes the use of a selection matrix in identifying suitable experts for the Delphi panel. A pilot study was used to test and validate the measuring instrument (3.2.2.7) before conducting the actual research. The data gathering (3.2.2.8) and data analysis (3.2.2.9) processes are described in Chapter 3. The discussion about ensuring the quality, reliability, validity and trustworthiness of this study (3.3) outlines measures taken to ensure rigour during this qualitative method of research.

Chapter 4 provides a detailed description of each round of the Delphi process – each time elaborating on the measuring instrument, providing an analysis of the responses and summarising the findings of the round. The chapter ends with a summative discussion on the outcome of the Delphi survey (4.2.5).

The knowledge and theory from the literature overview, combined with the findings from the Delphi survey, informed the recommendations for changes to the content and structure of the current postgraduate radiology curriculum of the UFS. These recommendations are described, in detail, in Chapter 6.

The accomplishment of this objective addressed research question Two.

7.2.3 Research Question Three

The research question was stated as:

How to develop a competency-based continuous assessment programme for postgraduate radiology training at the UFS?

The following objective was pursued:

The development of a transparent, accountable, appropriate and formative competency-based continuous assessment programme for postgraduate radiology training (at the UFS).

Information garnered during the literature overview underpinned the answering of the third research question. Answering this research question in the context of South Africa required the input form the leading role-players in postgraduate radiology education in South Africa. The researcher accomplished this through a series of semi-structured interviews with a panel of experts.

Chapter 3 describes the theoretical aspects of semi-structured interviews (3.2.3.1) before focussing on the use of semi-structured interviews in this study (3.2.2.2). This is followed by a description of the target population (3.2.3.3), the survey population (3.2.3.4), the sample size (3.2.3.5), and a description of the sample, including the selection matrix used for choosing suitable interviewees (3.2.3.6). The processes of data gathering (3.2.3.7) and data analysis (3.2.3.8) (including the coding of the interviews) are described in Chapter 3. Details about the steps taken to ensure quality, reliability and validity during this qualitative method of research is contained in the discussion about ensuring the quality, reliability, validity and trustworthiness of this study (3.3).

Chapter 5 discusses the data analysis of the semi-structured interviews (5.2) in detail. The chapter then collates the findings of the interviews, and elaborates on the analysis and description of the data, according to each of the core questions stated in the interview guide (5.3). The chapter concludes with a summative discussion on the outcome of the semi-structured interviews (5.4).

Combining the information garnered during the literature overview, the Delphi survey and the semi-structured interviews laid the platform for the development of a predominantly formative, competency-based, continuous assessment programme for postgraduate radiology training, tailored to the circumstances of the Clinical Imaging Science department at the UFS.

Chapter 6 describes in detail the different elements of the proposed assessment programme (6.4) and gives a clear indication of the integration between the curriculum and assessment programme.

The accomplishment of this objective addressed research question Three.

7.3 CONCLUSION

The outcome of postgraduate radiology final examinations in recent times have initiated discussion about summative exit examinations and the postgraduate radiology training programme of the UFS. The discussion centred on the shortcomings of the radiology exit examinations (especially with regard to assessing the overall performance of a candidate) and the importance of training programmes with regard to (ensuring) the development of competent graduates. These discussions raised several important questions, such as – "what comprises a competent graduate", "how does a registrar develop professional competence" and "how does one assess and prove competence?" A subsequent literary overview of international postgraduate radiology education programmes, prompted by these discussions, highlighted a focus on competency- and outcome-based educational principles, with frequent use of formative workplace-based assessments to ensure the development of competence throughout the training period. A comparison with the international training programmes highlighted several important shortcomings (cf. 1.3) on the part of the UFS training programme. This study therefore originated from the recognition that a gap exists in the postgraduate radiology training at the UFS and the rest of South Africa. In addressing the gap, the researcher developed a continuous assessment programme based on formative workplace-based assessments and blueprinted on the UFS postgraduate radiodiagnosis curriculum. In order to facilitate the integration of the assessment programme into the UFS postgraduate radiodiagnosis curriculum, the researcher recommended certain changes to the structure and content of the existing curriculum. The researcher furthermore proposes specific curricular changes aimed at bringing the UFS postgraduate radiodiagnosis curriculum in line with outcome-based educational principles, as well as ensuring the inclusion of non-radiological key competencies essential to all competent physicians.

A combination of methods was used to generate data. These findings were then interpreted to form the basis of the continuous assessment programme and the curricular recommendations.

The literature overview informed the theoretical framework, which evolved into theoretical perspectives that were later used to develop a conceptual framework on which the empirical research was based. The literature overview contextualised and conceptualised postgraduate radiology education. The literature elaborated on the widespread use of outcomes and competencies in postgraduate radiodiagnosis curricula and the inclusion of generic physician competencies – adaptations of the physician roles contained within the CanMEDS framework. Another important part of the literature overview focused on assessment in postgraduate medical education, specifically formative assessment. The research elucidated the general use of formative workplace-based assessments and how it applies to postgraduate radiology training, highlighting the importance of feedback and remedial action. The factual aspects of the literature overview were presented in Chapter 2.

The empirical research consisted of a Delphi survey that investigated the content of the curriculum, which in turn also informed the assessment programme, and semi-structured interviews that focussed on assessment during postgraduate radiology training.

The Delphi survey managed to organise the curricular content by grouping knowledge and procedural competencies into categories (consisting of levels of competence and timing of acquisition and mastery). It also determined – through consensus opinion – which specialty-related competencies could be excluded from a revised curriculum and which generic behaviour and attitude competencies should be included. The changes to the radiodiagnosis curriculum also guided the assessment schedule and influenced the use of the different formal assessments within a particular training level. The factual aspects and subsequent factual conclusions of the Delphi survey, as well as the analytical conclusions of the Delphi survey, were presented in Chapter 4.

The semi-structured interviews facilitated discussion about the assessment of registrars during their training. The interviews elucidated the realities of practice and the perceived challenges around formal workplace assessment, through the various opinions and views of key role-players in postgraduate radiology training in South Africa. It also gave insight into the general perceptions and understanding of key concepts such as workplace-based assessment, summative assessment, formative assessment, feedback and remedial action. All interviewees acknowledged the importance of formal workplace assessments and the advantages of formative assessment. Most were optimistic about a structured formal continuous assessment programme but warned against too many assessments and assessments that did not contribute directly to postgraduate radiology training. A few were concerned about staffing and timing issues, but most felt that with careful planning and the judicious use of resources this would not be a problem. The message was clear – it is important to adapt an assessment programme to the innate situation of each individual department. The factual aspects and subsequent factual as well as the analytical conclusions of the semi-structured interviews, were presented in Chapter 5.

On a conceptual level it became clear that formative workplace-based assessment has the potential to contribute significantly to postgraduate radiology training in South Africa. For this to happen requires acceptance and considerable commitment from both the heads of (the academic radiology) departments and the consultants involved in postgraduate radiology training. Implementing such an assessment programme throughout South Africa holds certain challenges. South African academic radiology departments differ in terms of available resources (human, expertise and equipment) and workloads. Developing a formative competency-based continuous assessment programme for postgraduate radiology education in South Africa will require consideration of the uniqueness of each academic department. Such a programme will have to accommodate adjustments made by each department according to their unique conditions, whilst still adhering to the same basic educational principles.

Although much can be learned from the various international radiodiagnosis curricula, South Africa has its own unique conditions and challenges that will have to be considered when attempting to design a uniform radiodiagnosis curriculum for the South African context. This will require considerable time and commitment from a group of qualified individuals. It will also require considerable cooperation between the different academic radiology departments, the College of Radiology of South Africa and the Radiological Society of South Africa. Despite the challenges of developing such a uniform prescriptive curriculum for South African postgraduate radiology education, it is the opinion of this researcher that this has been neglected for way too long.

Despite the study's focus on improving postgraduate radiology education at the UFS, the researcher intends to use the knowledge gained to provoke discussion about postgraduate radiology education in South Africa, which will hopefully lead to the development of a radiodiagnosis curriculum (which includes a formative competency-based continuous assessment programme) for South Africa.

7.4 LIMITATIONS OF THE STUDY

The researcher recognises certain limitations in the study:

The outcome of a Delphi survey is greatly influenced by the characteristics and quality of the expert panel. In this study the number of Delphi respondents were limited by the lack of depth in, and experience of, role-players responsible for the postgraduate radiology training programmes in South Africa. It would have been inappropriate to involve international experts, as these individuals – experienced and knowledgeable as they are – are mostly unfamiliar with the details surrounding conditions and limitations of postgraduate training in South Africa. Any limitations, as a result of the modest Delphi panel, were offset by the panellists' intimate and expert knowledge of postgraduate radiology education in the context of South Africa. This familiarity, combined with a high response rate and a high degree of consensus and stability, speaks in favour of the quality of the data and conclusions that emerged from the Delphi survey.

Although semi-structured interviews are guided by a set of core questions, the effect the interviewer has on the outcome of the interviews should not be ignored. In this regard, the researcher acknowledges his limitations as interviewer during the semi-structured interviews and his inexperience with the subsequent coding of the interviews. The possible advantage of using of a professional interviewer was offset by the researcher's intimate knowledge of the subject matter and the goals and aims of the research. The researcher's inexperience was compensated for through enthusiasm, guidance from the promoters, attention to trustworthiness, the use of an interview guide, piloting the semi-structured interview prior to commencing the actual interviews, and the researcher's professional relationship with each of the interviewees. These challenges were therefore embraced as an opportunity for personal development.

During the semi-structured interviews the researcher discovered a lack of in-depth knowledge about essential concepts – such as workplace-based assessment, formative assessment and the CanMEDS physician competency framework – amongst the interviewees. In all likelihood this influenced the views and opinions of the interviewees – however, instead of seeing this as a limitation it should be taken as representative of life as it is lived in reality, and as such adds to the quality (validity) of the research. To establish a basic level of understanding, concerning postgraduate assessment, formative assessment, workplace-based assessment, feedback and the CanMEDS roles, each interviewee received an information guide several days prior to the actual interview. They were encouraged to review the questions and the information ahead of time. In this document the researcher outlined the relevant concepts (cf. Appendix B3). Interviewees were also given the opportunity to clarify these concepts, or any other queries they may have had regarding the interview, prior to commencement of the interview.

The one aspect of the curriculum that the research did not address involves a detailed description of the clinical conditions and normal variants for each body system that registrars are expected to know. The task of compiling such a comprehensive syllabus of conditions that registrars are expected to know – in the context of South Africa – can be addressed in a postdoctoral project or study, preferably in collaboration with all relevant role players involved in postgraduate radiology education in South Africa.

Some concepts and ideas that form part of the assessment programme and the curricular changes, are not clearly and robustly linked to the outcome of the empirical research. Instead, they originated from discussions with promoters and knowledgeable individuals (not reported in the thesis) and the researchers personal experience, expertise and knowledge gained whilst conducting the research. These concepts and ideas were mostly discussed with the promoters prior to inclusion.

7.5 CONTRIBUTION AND SIGNIFICANCE OF THIS RESEARCH

The research constitutes a moderate contribution to new knowledge on two separate, yet interconnected, fronts. A sound research approach and methodology ensured the quality, reliability and validity of the research.

The research involved a critical revision of the existing postgraduate curriculum of the UFS, which lead to research-based recommendations of changes to the content and structure of the radiodiagnosis curriculum, ensuring the inclusion of non-medical expert physician roles and bringing it in line with international radiodiagnosis curricula.

The research also culminated in the development of a continuous assessment programme (for postgraduate radiology training at the UFS) consisting for the most part of formative workplace-based assessments. The assessment programme aims to assess the registrar's performance at regular intervals and so monitor his or her progress, whilst at the same time contributing to the registrar's learning and training, and ensuring the acquisition and mastery of essential competencies.

Initial research defined the *gap in knowledge* – an out-dated radiodiagnosis curriculum and an assessment programme that contributed very little, if anything to the training of the registrars. The subsequent development of recommendations concerning changes to the curriculum and the development of a continuous assessment programme (discussed in Chapter 6) addressed the perceived *gap in knowledge*. The researcher is of the opinion that the research will significantly improve the quality of the UFS postgraduate radiology training programme and in so doing, will benefit all patients imaged at the Pelonomi, National and Universitas hospital radiology departments, with further benefits to clients of graduates going into private practice. Overall, this research has the ability to contribute significantly to postgraduate radiology education and training throughout South Africa and thus benefiting the radiology profession of South Africa, and the public they serve.

Although the research was aimed specifically at postgraduate radiology training at the UFS, the recommendations are based on principles that are relevant to South African postgraduate radiology education and training in general, and as such, many of these ideas and principles can be incorporated into training programmes across South Africa.

On a more personal note, the research study contributed significantly to the personal development of the researcher. The researcher gained valuable insight and first-hand experience into the diverse aspects of research. Furthermore, the project not only introduced the researcher to the multifarious – and often confusing – facets of higher education, but also cultivated a deeper interest that is sure to contribute to the researcher's primary function as an academic radiology specialist involved in the postgraduate education and training of radiology.

7.6 RECOMMENDATIONS

For the study to contribute to postgraduate radiology training at the UFS the researcher makes the following recommendations:

The submission of the research findings and recommendations to the Executive Management of the School of Medicine and the Department of Clinical Imaging Science, UFS for consideration, further recommendations and implementation as the way forward in the education and training of registrars in postgraduate radiology at the UFS.

Informing and educating consultant radiologists at the Department of Clinical Imaging Sciences, UFS on the basic educational principles embedded in modern-day radiology education and training, as well as the principles and concepts associated with the proposed assessment programme. This can be accomplished through scheduled informative sessions presented by experts on the topic.

The implementation of the proposed assessment programme based on regular scheduled formal workplace-based assessments which include feedback, remediation and documentation, supported by frequent unscheduled informal formative workplace-based assessments which lead to feedback that benefit learning.

Implementation of the summative assessment at the end of the Level Two instructional period (*cf.* 6.4.3.1) and the summative intermediate examination at the end of the Level Three instructional period (*cf.* 6.4.3.2).

The development of a formative progress test (*cf.* 2.2.3.4) to be incorporated into the UFS radiology training programme. International image and question libraries – for example the Dutch Radiology Progress Test – can, with the necessary permission, be adapted to the South African context. The progress test is intended to form part of the quarterly assessments and mandatory for all registrars.

For the study to contribute to postgraduate radiology training in South Africa the researcher makes the following recommendations:

Presenting the proposed continuous assessment programme for scrutiny and validation by experts. Once necessary amendments have been made, discussions should commence on how and in which form this assessment programme can be implemented at the other academic radiology departments across South Africa.

A panel of qualified and committed individuals should be called into existence to start work on a new unitary and detailed radiodiagnosis curriculum for the postgraduate education and training of diagnostic radiology at universities across South Africa, ensuring a unified and uniform approach to the training of registrars. All forms of assessment (including the final exit examination) should be blueprinted on the new curriculum and based on the content as described in the new syllabus.

Informing and educating consultant radiologists at the academic radiology departments across South Africa on the basic educational principles embedded in modern-day radiology education and training, as well as the principles and concepts associated with the formative and workplace-based assessment. This can be accomplished through scheduled informative sessions presented by experts on the topic.

Elucidating the basic educational principles embedded in modern-day radiology education and assessment through the publication of a series of informative articles in the South African Journal of Radiology.

7.7 CONCLUSIVE REMARKS

In order to ensure the quality of a graduate radiologist, a training programme should provide the necessary guidance and an environment conducive to the development of competence through experience and mastery of the competencies prescribed in the radiodiagnosis curriculum. Also essential to the success of a training programme is the regular and formal assessment of a registrar's performance. Although the assessment of registrars cannot guarantee future performance, it is the best we can do (for now) to ensure professional behaviour, provide the trainee with direction and motivation for continued future learning, maintain high professional standards and protect the public.

"Change does not necessarily assure progress,
but progress implacably requires change.
Education is essential to change,
for education creates both new wants
and the ability to satisfy them."

Henry Steele Commager
1902-1998

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APPENDIX A1

LETTER OF INVITATION TO PARTICIPATE IN A DELPHI QUESTIONNAIRE SURVEY

Department Clinical Imaging Sciences
University of the Free State
Bloemfontein
South Africa

Date

Dear (participant)

Re: Invitation to Participate in a Delphi Questionnaire Survey

I am a Senior Lecturer/Principal Specialist in the Department of Diagnostic Radiology (Clinical Imaging Sciences) at the University of the Free State/ Universitas Hospital, and currently enrolled at the UFS for doctoral studies.

For my Ph.D. in Health Sciences Education I am doing a study on Postgraduate Training in Diagnostic Radiology in South Africa (and specifically at the University of the Free State). The title of my thesis is: *A Competency-based Continuous Assessment Programme as part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State* (UFS Ethics Committee approval number – Ecufs no 80/2013).

The **purpose of the research** is to devise a reliable, accurate, reproducible and timely competency-based continuous assessment programme that will allow the formative and progressive assessment of an individual's progress throughout his/her registrar training. The assessment programme will incorporate predetermined and well-defined learning outcomes – these will be available to the student on entering the postgraduate training programme. This will present the registrars with a blueprint of what is expected of them at different stages/levels of their training, effectively guiding them through the postgraduate training period. The assessment programme will serve as the basis for continued assessment – the (accumulative) results of which will determine the candidate's eligibility to sit their final examination. Being formative in nature implies that each assessment will be followed by a (structured) feedback session, which – where necessary - should result in the modification and guidance of further learning in an attempt to correct any inadequacies/incompetence identified at the time of the assessment. To support such an assessment programme based on outcomes and competencies will require revision of the present postgraduate radiology training curriculum, starting with defining the attributes of the successful candidate.

The **relevance of this research** lies in the outcomes-based academic guidance both the candidates and supervisors will be provided with in order to better train and educate registrars, which in turn will more fully prepare the registrars for their final examinations, ensuring a better pass rate and a high qualifying standard on par with international standards.

The **overall goal of the study** is to improve the postgraduate diagnostic radiology training programme at the UFS (and possibly in South Africa) in order to ensure that registrars are optimally prepared and ready to successfully sit their examinations (with the best possible chance of passing).

Because of your expertise and experience in the field of diagnostic radiology I am inviting you to participate in this study. Your involvement will require of you to complete a questionnaire that will be sent to you both by mail and electronically. The questionnaire will focus on the curriculum for postgraduate study in diagnostic radiology and which competencies, in terms of skills and knowledge, you expect a registrar to have acquired by the end of his/her studies in order to be competent to undertake the practice of either a private or academic radiologist.

For this part of the research, for which you are being invited, we are going to use the Delphi method of research. The Delphi method of research, or simply Delphi survey, involves the use of questionnaires. Members of an expert panel each receives an identical questionnaire, which needs to be returned, answered, to the facilitator. The answers are then analysed and the original questionnaire modified, removing some questions and adding new questions. The modified questionnaire and an anonymous summary of the experts' opinions from the previous round (as well as the reasons provided for the opinions and views) are then forwarded to the participants for the second round of the survey. Thus, experts are encouraged to revise their earlier responses in light of the replies of other members of the panel. It is believed that during this process the range of the answers will decrease and the group will converge towards the "correct" answer. Further rounds may follow as necessitated by the outcome of each round. Finally, the process is stopped after a pre-defined stop criterion (e.g. number of rounds, achievement of consensus or stability of results) and the mean or median scores of the final rounds determine the results. The results of this process will form the basis for the final structure of the curriculum for postgraduate radiology training at the University of the Free State.

Participation is strictly voluntary.

There is no compensation for participating, nor is there any known risk.

Your participation (and that of all the other participants) is confidential and no reference will be made to any names, not even on completion of or publications from the thesis. I wish to give you my assurance that all data collected during the course of the research will be treated confidentially at all times.

The information you provide will form the basis of my thesis and will most certainly help shape the future training of radiology registrars at the University of the Free State.

Completing the Round One questionnaire should take no more than an hour and you can expect to spend less time completing the questionnaire during each of the subsequent rounds. Commencement of Round One is planned for 16 September 2013 with completion of the entire survey by no later than 29 November 2013 (earlier in the event of consensus).

You may contact Ms J du Plessis, Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS at telephone number (051) 4052812 if you have questions about your rights as a research subject.

Should you have any queries or require any further information, please do not hesitate to mail me at naudburg@iclix.co.za or jansevrj@ufs.ac.za. Alternatively you may contact me on 0828903044.

The promoters for this PhD study are:

Promoter	**Co-promoter**	**Co-promoter**
Prof (MM) Marietjie Nel	Prof (GJ) Gert van Zyl	Prof (CS) Coert De Vries
Head: Division Health Sciences Education	Dean: Faculty of Health Sciences	Head: Department Clinical Imaging Sciences
Faculty of Health Sciences	University of the Free State	University of the Free State
NelMM@ufs.ac.za	vanzylgj@ufs.ac.za	deVriesC@ufs.ac.za

If you are prepared to participate in the Delphi survey, please complete the accompanying consent form and fax it to 0862281880 at your earliest convenience.

If you are not available please inform me in writing by sending an email to naudburg@iclix.co.za or jansevrj@ufs.ac.za.

It is imperative that you do not discuss your participation (in this study) with any of your colleagues - this is vitally important for the preservation of the validity and reliability of the study.

Thank you for considering my request.

Yours faithfully

Dr Jacques Janse van Rensburg M.Med Rad (Diag)
Department of Clinical Imaging Sciences
University of the Free State
Bloemfontein
South Africa

APPENDIX A2

CONSENT FORM: DELPHI SURVEY

I, the undersigned, hereby agree to be a participant in the Delphi survey being conducted as part of the Ph.D. study with the title *A Competency-based Continuous Assessment Programme as Part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State* (Ecufs no 80/2013).

I understand that my participation in the Delphi survey is confidential and that there will be no references to any names. All data collected during the survey will be treated confidentially at all times. I am also of the understanding that I will not be held accountable for any decisions or conclusions emanating from the study. I furthermore acknowledge that the results from this research will be published.

My full particulars are:

Title ______________________________

Surname ______________________________

Full names ______________________________

Contact number ______________________________

E-mail address ______________________________

Years associated with an academic institution and/or involved with registrar teaching

____

Years of practice since having qualified as a radiologist ________________

Signature ______________________________ Date ________________

It is imperative that you discuss neither the content of the questionnaire, nor your participation in the Delphi survey, with any of your colleagues – this is done in order to ensure the validity and reliability of the survey.

Please complete the document and fax to 0862281880.

THANK YOU FOR PARTICIPATING IN THIS DELPHI SURVEY

APPENDIX A3

INSTRUCTIONS FOR COMPLETION OF THE DELPHI QUESTIONNAIRE: ROUND 1

A Competency-based Continuous Assessment Programme as Part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State.

Ethics Committee UFS nr 80/2013

DELPHI SURVEY ROUND ONE

Please save a copy of this document to your computer hard drive. Use this saved copy when completing the questionnaire. During completion of the questionnaire, I recommend that you save regularly – especially before taking a break. Upon completion of the questionnaire, please e-mail the completed document to naudburg@iclix.co.za or jansevrj@ufs.ac.za

Alternatively, you may print the document and complete the questionnaire by hand. In this case, please fax the completed document to 0862281880.

If you experience any problems or have any queries, contact me at 0828903044 or send me an e-mail at either naudburg@iclix.co.za or jansevrj@ufs.ac.za

You will likely need between 60 and 90 minutes to complete the questionnaire. The questionnaire consists of two main sections that allows for a natural break in proceedings. The initial questionnaire should take the longest to complete, with subsequent questionnaires taking progressively less time as questions are eliminated through consensus.

I ask that you please return the completed questionnaire before ________________.

You are again reminded not to discuss the questionnaire or your participation in the Delphi survey with any of your colleagues.

SECTION ONE – THE CURRICULUM

This section addresses the curriculum in terms of expected outcomes for a diagnostic radiology graduate. A curriculum incorporating an outcomes-based model starts by defining the attributes of the successful graduate (the final product) and then plan backwards; figuring out how to know whether a student has attained those outcomes and creating opportunities that will enable the student to achieve the predetermined outcomes. Outcomes-based education therefore emphasises what we expect the students will have achieved when they complete their training period (course).

Expected outcomes are listed according to what a graduate is expected to know and what skills (practical, knowledge and behaviour) are expected of them.

Heading 1 of each subsection deals with the knowledge a candidate is expected to have amassed/mastered by the end of the registrar training period. For each subject please indicate whether you expect the registrar to have an advanced/expert knowledge of the particular subject, whether a basic knowledge is good enough, or whether knowledge of the subject is not essential/optional - the candidate will therefore not be assessed on this topic/subject and questions on this topic will not be included in the final examination. Please choose one of the following options:

- Advanced (the candidate is expected to have an advanced/expert knowledge of this subject – which in this case implies a broader and more detailed knowledge than what can be expected with a basic knowledge).
- Basic (a basic knowledge of this subject is adequate – a basic knowledge, in this case, refers to a level of knowledge (about the subject) equivalent to the level of knowledge presented in the radiology textbook of Grainger and Allison).
- Unnecessary (knowledge of this subject is not essential/optional and the registrar will not be assessed on this topic, neither will questions about this topic be included in the final examination).

Heading 2 of each subsection deals with which skills (practical, knowledge and behaviour) a registrar should have acquired by the end of the training period. Please mark only one of the following options:

- Advanced – an advanced skill level allows an individual to safely and competently perform a procedure/skill on his/her own – without supervision – and also qualifies them to teach or train colleagues.
- Basic – a basic skill level implies that the registrar has enough knowledge and skill to perform a procedure under supervision and with/without help.
- Unnecessary – this skill is not essential/optional and the registrar will not be assessed on this topic, neither will questions about this topic be included in the final examination.

Mark the appropriate block with an X – please mark only one of the available choices. A space for comments regarding the specific question has been has been left after each question - at the end of each subsection is space for more general comments regarding that specific subsection.

This section of the questionnaire will not address physics, pathology or anatomy as separate entities, but will instead focus on diagnostic radiology as the main subject in postgraduate radiology training (which may include anatomy, physics and procedural aspects where applicable).

The aim of this questionnaire is also not to give a detailed layout of the theoretical knowledge a graduate should have – where applicable, however, reference will be made to certain medical or surgical conditions.

SECTION TWO – CONTINOUS ASSESSMENT

This section addresses the continuous formative assessment of a registrar during the training programme. The information gathered from this section of the questionnaire will be used to construct a continuous assessment programme, spanning the entire training programme. At its core, this structured programme will consist of numerous assessments (using different assessment tools) at predetermined times. It will be based on the formative assessment of predetermined skills and according to predetermined time bound outcomes. The outcome of each assessment will contribute towards the candidate's portfolio, which will be used in deciding whether or not he/she may attempt the final radiology examination. The continuous evaluation and formative nature of this programme aims to identify shortcomings in the registrar's progress, address and correct these shortcomings and modify his/her future learning.

The aim of this survey is therefore to determine the structure and content of such a continuous assessment programme. The choice of assessment tools to be used in the various assessments, however, does not form part of this survey.

You are requested to indicate at what time you expect a registrar to have achieved the indicated skill (whether it is knowledge or a practical/procedural skill).

- End of year one (it is assumed that a registrar will have rotated through all imaging modalities at least once after one year).
- End of year three (in line with the).
- End of year five (keep in mind that the training period for postgraduate radiology at the UFS extends over five years – this is the equivalent of the last year of a four year programme).
- Not necessary (you do not believe that is necessary for a registrar to have achieved competence in this skill at any point and should therefore not be formally assessed in terms of competence).

Mark the appropriate block with an X - please mark only one of the available choices. A space for comments regarding the specific question has been has been left after each question - at the end of each subsection is space for more general comments regarding that specific subsection.

Thank you for your willingness to share of your time and expertise, without which this PhD would not be possible.

APPENDIX A4

INSTRUCTIONS FOR COMPLETION OF THE DELPHI QUESTIONNAIRE: ROUND 2

A Competency-based Continuous Assessment Programme as Part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State

Ethics Committee UFS nr 80/2013

DELPHI SURVEY ROUND TWO

Please save a copy of this document to your computer hard drive. Use this saved copy when completing the questionnaire. During completion of the questionnaire, I recommend that you save regularly – especially before taking a break. Upon completion of the questionnaire, please e-mail the completed document to naudburg@iclix.co.za or jansevrj@ufs.ac.za

Alternatively, you may print the document and complete the questionnaire by hand. In this case, please fax the completed document to 0862281880.

If you experience any problems or have any queries, contact me at 0828903044 or send me an e-mail at either naudburg@iclix.co.za or jansevrj@ufs.ac.za

SECTION ONE – THE CURRICULUM

This section addresses the curriculum in terms of expected outcomes for a diagnostic radiology graduate.

Heading 1 of each subsection deals with the knowledge a candidate is expected to have amassed/mastered by the end of the registrar training period. For each subject please indicate whether you expect the registrar to have an advanced/expert knowledge of the particular subject, whether a basic knowledge is good enough, or whether knowledge of the subject is not essential/optional - the candidate will therefore not be assessed on this topic/subject and questions on this topic will not be included in the final examination.

Heading 2 of each subsection deals with which skills (practical, knowledge and behaviour) a registrar should have acquired by the end of the training period. Please mark only one of the following options:

- Advanced – an advanced skill level allows an individual to safely and competently perform a procedure/skill on his/her own – without supervision – and also qualifies them to teach or train colleagues.
- Basic – a basic skill level implies that the registrar has enough knowledge and skill to perform a procedure under supervision and with/without help.
- Unnecessary – this skill is not essential/optional and the registrar will not be assessed on this topic, neither will questions about this topic be included in the final examination.

Mark the appropriate block with an X. Please mark only one of the available choices.

SECTION TWO – CONTINOUS ASSESSMENT

This section addresses the continuous formative assessment of a registrar during the training programme. The information gathered from this section of the questionnaire will be used to construct a continuous assessment programme, spanning the entire training programme. The choice of assessment tools to be used in the various assessments, however, does not form part of this survey.

You are requested to indicate at what time you expect a registrar to have achieved the indicated skill (whether it is knowledge or a practical/procedural skill).

- End of year one (it is assumed that a registrar will have rotated through all imaging modalities at least once after one year).
- End of year three (in line with the core curriculum of three years as adopted by many of the oversees curriculums).

- End of year five (keep in mind that the training period for postgraduate radiology at the UFS extends over five years – this is the equivalent of the last year of a four year programme).
- Not necessary (you do not believe that is necessary for a registrar to have achieved competence in this skill at any point and should therefore not be formally assessed in terms of competence).

Mark the appropriate block with an X. Please mark only one of the available choices.

APPENDIX A5

INSTRUCTIONS FOR COMPLETION OF THE DELPHI QUESTIONNAIRE: ROUND 3

A Competency-based Continuous Assessment Programme as Part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State.

Ethics Committee UFS nr 80/2013

DELPHI SURVEY ROUND THREE

Please save a copy of this document to your computer hard drive. Use this saved copy when completing the questionnaire. During completion of the questionnaire, I recommend that you save regularly – especially before taking a break. Upon completion of the questionnaire, please e-mail the completed document to naudburg@iclix.co.za or jansevrj@ufs.ac.za

Alternatively, you may print the document and complete the questionnaire by hand. In this case, please fax the completed document to 0862281880.

If you experience any problems or have any queries, contact me at 0828903044 or send me an e-mail at either naudburg@iclix.co.za or jansevrj@ufs.ac.za

SECTION ONE – THE CURRICULUM

This section addresses the curriculum in terms of expected outcomes for a diagnostic radiology graduate.

Heading 1 of each subsection deals with the knowledge a candidate is expected to have amassed/mastered by the end of the registrar training period. For each subject please indicate whether you expect the registrar to have an advanced/expert knowledge of the particular subject, whether a basic knowledge is good enough, or whether knowledge of the subject is not essential/optional - the candidate will therefore not be assessed on this topic/subject and questions on this topic will not be included in the final examination.

Heading 2 of each subsection deals with which skills (practical, knowledge and behaviour) a registrar should have acquired by the end of the training period. Please mark only one of the following options:

- Advanced – an advanced skill level allows an individual to safely and competently perform a procedure/skill on his/her own – without supervision – and also qualifies them to teach or train colleagues.
- Basic – a basic skill level implies that the registrar has enough knowledge and skill to perform a procedure under supervision and with/without help.
- Unnecessary – this skill is not essential/optional and the registrar will not be assessed on this topic, neither will questions about this topic be included in the final examination.

Mark the appropriate block with an X. Please mark only one of the available choices.

SECTION TWO – CONTINOUS ASSESSMENT

This section addresses the continuous formative assessment of a registrar during the training programme.

You are requested to indicate during which stage you expect a registrar to have achieved a particular skill (whether it is knowledge or a practical/procedural skill).
Evaluation - in terms of competence - of the particular skill will also occur within the period you have selected (whether it is first half or the second half of the training period).

The amended choices are:

- The first half of the training period (a period defined by (the initial) 50% of the total training period irrespective of the length of the training period).
- The second half of the training period (a period defined by (the latter) 50% of the total training period irrespective of the length of the training period).

- Not necessary (you do not believe that is necessary for a registrar to have achieved competence in this skill at any point and should therefore not be formally assessed in terms of competence).

Mark the appropriate block with an X. Please mark only one of the available choices.

APPENDIX A6

INSTRUCTIONS FOR COMPLETION OF THE DELPHI QUESTIONNAIRE: ROUND 4

A Competency-based Continuous Assessment Programme as Part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State

Ethics Committee UFS nr 80/2013

DELPHI SURVEY ROUND FOUR

Please save a copy of this document to your computer hard drive. Use this saved copy when completing the questionnaire. During completion of the questionnaire, I recommend that you save regularly – especially before taking a break. Upon completion of the questionnaire, please e-mail the completed document to naudburg@iclix.co.za or jansevrj@ufs.ac.za

Alternatively, you may print the document and complete the questionnaire by hand. In this case, please fax the completed document to 0862281880.

If you experience any problems or have any queries, contact me at 0828903044 or send me an e-mail at either naudburg@iclix.co.za or jansevrj@ufs.ac.za

SECTION ONE – THE CURRICULUM

This section addresses the curriculum in terms of expected outcomes for a diagnostic radiology graduate.

Heading 1 of each subsection deals with the knowledge a candidate is expected to have amassed/mastered by the end of the registrar training period. For each subject please indicate whether you expect the registrar to have an advanced/expert knowledge of the particular subject, whether a basic knowledge is good enough, or whether knowledge of the subject is not essential/optional - the candidate will therefore not be assessed on this topic/subject and questions on this topic will not be included in the final examination.

Heading 2 of each subsection deals with which skills (practical, knowledge and behaviour) a registrar should have acquired by the end of the training period. Please mark only one of the following options:

- Advanced – an advanced skill level allows an individual to safely and competently perform a procedure/skill on his/her own – without supervision – and also qualifies them to teach or train colleagues.
- Basic – a basic skill level implies that the registrar has enough knowledge and skill to perform a procedure under supervision and with/without help.
- Unnecessary – this skill is not essential/optional and the registrar will not be assessed on this topic, neither will questions about this topic be included in the final examination.

Mark the appropriate block with an X. Please mark only one of the available choices.

This questionnaire – round four of the Delphi survey – contains the last of the questions on which consensus has not been reached.

In the 'comment' column – next to each question – you will find an indication of how many respondents choose which particular option for each individual question in the last round.

Example – for the question below 66% of the respondents chose option **A** (that is advanced), 33% of respondents indicated option **B** (basic) whilst none of the respondents indicated **C** (unnecessary) as their choice.

		ADVANCED	**BASIC**	**UNNECASSARY**	**COMMENTS**
c	The physics of mammography image production and how it affects image quality				A=66% B=33% C=0%

You are not expected to change your answers to coincide with the majority vote BUT, as with all the previous rounds, you have the option of changing your opinion and therefore your previous answers to an individual question.

SECTION TWO – CONTINOUS ASSESSMENT

This section addresses the continuous formative assessment of a registrar during the training programme.

You are requested to indicate during which stage you expect a registrar to have achieved a particular skill (whether it is knowledge or a practical/procedural skill).
Evaluation - in terms of competence - of the particular skill will also occur within the period you have selected (whether it is first half or the second half of the training period).

The amended choices are:

- The first half of the training period (a period defined by (the initial) 50% of the total training period irrespective of the length of the training period).
- The second half of the training period (a period defined by (the latter) 50% of the total training period irrespective of the length of the training period).
- Not necessary (you do not believe that is necessary for a registrar to have achieved competence in this skill at any point and should therefore not be formally assessed in terms of competence).

Mark the appropriate block with an X. Please mark only one of the available choices.

APPENDIX A7

DELHI QUESTIONNAIRE AND CONSENSUS DOCUMENT

DELPHI QUESTIONNAIRE CONSENSUS DOCUMENT
SECTION ONE

Guide to colour coding used in this table

Indicates consensus achieved during round **one**	Indicates consensus achieved during round **three**
Indicates consensus achieved during round **two**	Indicates consensus achieved during round **four**

A - BREAST IMAGING

1 - By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	*The anatomy of the breast:*				
	5) normal anatomy	R2			
	6) normal anatomical variants	R2			
b	Age related breast changes	R2			
c	The physics of mammography image production and how it affects image quality	R4			
d	*The respective roles (including indications) of the following imaging studies in terms of breast imaging:*				
	13) mammography	R1			
	14) tomosynthesis		R1		
	15) breast MRI		R1		
	16) breast ultrasound	R1			
	17) elastography		R1		
	18) PET CT		R1		
	19) sentinel node imaging		R1		
	20) ductography		R3		
e	*The limitations of the following imaging studies in terms of breast imaging:*				
	1) mammography	R1			
	2) tomosynthesis		R3		
	3) breast MRI		R4		
	4) breast ultrasound	R2			
	5) elastography		R1		
	6) PET CT		R1		
	7) sentinel node imaging		R4		
	8) ductography		R3		
f	The principles and issues related to breast cancer screening		S		A=33% B=66% C=00%
g	BI-RADS (Breast Imaging Reporting and Data System)	R2			
h	Benign breast conditions	R2			
i	Malignant breast conditions	R2			
j	*Breast cancer:*				
	1) risk factors		R4		
	2) clinical presentation		R3		
	3) radiological presentation	R2			
	4) diagnosis	R2			

	5) treatment		R1		
	6) follow-up after treatment	R2			
	7) spectrum of radiological appearances after surgical procedures	R2			
2 - By the end of the registrar training period a candidate should be able to:					
		ADVANCED	**BASIC**	**UNNECASSARY**	**COMMENTS**
a	*Interpret mammograms diagnostically:*				
	3) recognize the normal anatomy on a mammogram	R1			
	4) discriminate between benign and malignant imaging findings	R1			
b	*Perform diagnostic ultrasounds of the breast:*				
	3) discriminate between solid and cystic masses	R1			
	4) recognise (typical and atypical) features of benign and malignant lesions	R1			
c	Interpret breast MRI diagnostically		R2		
d	Write clear, accurate and succinct reports using the BI-RADSystem	R1			
e	Perform ductograms		R4		
f	Interpret ductograms diagnostically		R4		
g	Perform ultrasound guided FNAs of a breast lesion – solid or cystic	R1			
h	Perform stereotactic biopsies	R1			
i	Perform vacuum-assisted breast biopsies		R4		
j	Communicate malignant results to patients		R4		
k	Discuss likely treatment of breast cancer with the patient		R4		
l	Be able to discuss complex cases with referring clinicians and colleagues	R2			
m	Assume a leadership role in multidisciplinary meetings		R4		

B – CARDIAC IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:					
		ADVANCED	**BASIC**	**UNNECASSARY**	**COMMENTS**
a	*Cardiac vascular anatomy:*				
	5) normal anatomy	R2			
	6) normal anatomical variants	R2			
b	*The respective roles (including indications) of the following imaging studies in terms of cardiac imaging:*				
	5) cardiac CT Angiography (includes heart and coronary imaging)		R3		
	6) CT Angiography (aortagram and arteriography)	S			A=55% B=33% C=11%
	7) MRI cardiac imaging (including viability studies)		R1		
	8) echocardiography		R2		
	9) nuclear cardiac studies		R1		
c	*The limitations of the following imaging studies in terms of cardiac imaging:*				
	1) cardiac CT Angiography (includes heart and coronary imaging)		R1		

	2) CT Angiography (aortagram and arteriography)	R2			
	3) MRI cardiac imaging (including viability studies)		R1		
	4) echocardiography		R4		
	5) nuclear cardiac studies		R1		
2 - By the end of the registrar training period a candidate should be able to:					
		ADVANCED	**BASIC**	**UNNECASSARY**	**COMMENTS**
a	Drain a pericardial effusion		R4		
b	*Interpret cardiac imaging examinations accurately and safely:*				
	1) plain x-ray	R1			
	2) cardiac calcium score		S		A=22% B=66% C=11%
	3) cardiac CT angiography		R4		
	4) CT Angiography (aortagram and arteriography)	R2			
	5) cardiac MRI (including viability studies)		R1		
	6) cardiac echocardiography		S		A=00% B=55% C=44%
c	Write clear, accurate and succinct reports	S	S		A=44% B=44% C=11%

C – THORACIC IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:					
		ADVANCED	**BASIC**	**UNNECASSARY**	**COMMENTS**
a	*Applied anatomy relevant to radiological diagnosis of thoracic disease*				
	5) normal anatomy	R1			
	6) normal anatomical variants	R1			
b	Terminology relevant to thoracic imaging (Fleischner Glossary)	R2			Removed 2005 R2
c	The appearance and positioning of lines, tubes and devices	R2			
d	Routinely performed thoracic surgical procedures		R4		
e	Radiological appearances following common thoracic surgical procedures		R4		
f	The management of the solitary pulmonary nodule (Fleischner guidelines)	R1			
g	The diagnosis of common thoracic malignancies	R1			
h	The TNM staging of common thoracic malignancies	R2			
i	The treatment of common thoracic malignancies		R1		
j	The follow-up of common thoracic malignancies after treatment		S		A=33% B=66% C=00%
k	Imaging findings applicable to interstitial lung disease as identified on HRCT lung	R2			
l	*The respective roles (including indications) of the following imaging studies in terms of thoracic imaging:*				
	11) chest radiograph	R1			
	12) thoracic CT and CT Angiography	R2			
	13) DECT applications to thoracic imaging		R1		
	14) VQ scanning for pulmonary embolism assessment		R1		
	15) PET CT	R1			

	16) ultrasound	S			A=55% B=44% C=00%
	17) MRI	R4			
	18) bronchoscopy		R4		
m	*The limitations of the following imaging studies in terms of thoracic imaging:*				
	1) chest radiograph	R1			
	2) thoracic CT and CT Angiography	R2			
	3) Dual Energy CT applications to thoracic imaging		R3		
	4) VQ scanning for pulmonary embolism assessment		R4		
	5) PET CT	R1			
	6) ultrasound		R4		
	7) MRI	S			A=55% B=44% C=00%
	8) bronchoscopy		R4		
n	*Image guided lung biopsies:*				
	1) indications	R2			
	2) contraindications	R2			
	3) limitations	R2			
	4) complications	R2			
o	*Image guided pleural fluid drainage:*				
	1) indications		R4		
	2) contraindications		R4		
	3) limitations		R4		
	4) complications		R4		

2 - By the end of the registrar training period a candidate should be able to:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	*Interpret chest imaging examinations accurately and safely:*				
	1) plain chest radiograph	R1			
	2) fluoroscopic diaphragm screening	R2			Introduced R2
	3) HRCT for interstitial lung disease	R2			Introduced R2
	4) CT chest (including CT pulmonary angiography)	R1			
	5) MRI chest		R4		
	6) VQ scan for pulmonary embolism		R4		Introduced R2
	7) PET CT		R4		Introduced R2
b	Diagnose lung disease on HRCT	R2			
c	Perform image-guided drainage of pleural effusions	R4			
d	Perform image-guided lung biopsies		S		A=44% B=55% C=00%
e	Report a certain percentage (of a predetermined amount) of chest radiographs correctly in a specified amount of time	R1			
f	Write clear, accurate and succinct reports	R1			
g	Be able to discuss complex cases with referring clinicians and colleagues	R1			
h	Advise on the most appropriate imaging modality for a given problem	R1			
i	Assists in formulating an imaging and management plan as necessary	R1			

D – GASTROINTESTINAL IMAGING

(oesophagus / stomach / small bowel / colon / liver / gallbladder / pancreas / spleen / adrenals / peritoneal cavity)

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	*Normal anatomy of the:*				
	7) gastrointestinal tract	R1			
	8) hepatobiliary tract	R1			
	9) pancreas	R1			
b	*Normal variant anatomy of the:*				
	7) gastrointestinal tract	R2			
	8) hepatobiliary tract	R2			
	9) pancreas	R2			
c	Radiological appearance of anatomically changes after common relevant surgical procedures	R2			
d	Radiological appearance of the complications of common surgical procedures	R2			
e	*The respective roles (including indications) of the following imaging studies in terms of gastrointestinal imaging:*				
	18) barium/contrast screening studies	R1			
	19) ultrasound	R2			
	20) contrast enhanced ultrasound		R1		
	21) endoscopic ultrasound		R3		
	22) CT	R2			
	23) Dual Energy CT (as is applicable to gastrointestinal imaging)		R1		
	24) CT colonography (Virtual Colonoscopy)		R1		
	25) MRI	R2			
	26) MR enterography and enteroclysis		R1		
	27) capsule endoscopy		R4		
	28) Percutaneous Transhepatic Cholangiogram (PTC)		R1		
	29) gastroscopy		R4		
	30) colonoscopy		R4		
f	*The limitations of the following imaging studies in terms of gastrointestinal imaging:*				
	1) barium/contrast screening studies	R1			
	2) ultrasound	R2			
	3) contrast enhanced ultrasound		R3		
	4) endoscopic ultrasound		R3		
	5) CT	R2			
	6) Dual Energy CT (as is applicable to gastrointestinal imaging)		R3		
	7) CT colonography (Virtual Colonoscopy)		R1		
	8) MRI	R2			
	9) MR enterography and enteroclysis		R1		
	10) capsule endoscopy		R4		
	11) PTC		R1		
	12) gastroscopy		R4		
	13) colonoscopy		R4		
g	*The principles, indications and limitations of the following nuclear medicine investigations in gastrointestinal imaging:*				
	6) nuclear medicine GIT bleeding studies		R4		
	7) Meckels scans		R4		
	8) Octreotide Scanning		R4		

	9) MIBG		R1		
	10) PET scan		R1		
h	The indications of relevant contrast (screening) imaging examinations	R1			
i	The contraindications of relevant contrast (screening) imaging examinations	R1			
j	The limitations of relevant contrast (screening) imaging examinations	R1			
k	The indications of relevant ultrasound, CT and MRI investigations in gastrointestinal imaging	R1			
l	The limitations of ultrasound, CT and MRI in gastrointestinal imaging	R1			
m	*The indications, contraindications and complications of the following interventional procedures:*				
	10) percutaneous transhepatic cholangiography	R2			
	11) percutaneous transhepatic biliary stenting and drainage procedures		R4		
	12) radiofrequency (RF) ablation of liver lesions		R1		
	13) transarterial catheter-directed chemo embolization (TACE) of hepatic tumours		R1		
	14) percutaneous cholecystostomy		R4		
	15) transarterial catheter-directed diagnosis and treatment of gastrointestinal bleeding		R1		
	16) liver biopsies		R1		
	17) pancreas biopsies		R1		
	18) drainage procedures for intra-abdominal fluid collection and abscesses	R2			

2 - By the end of the registrar training period a candidate should be able to:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	Perform a range of barium/contrast screening studies	R1			
b	Perform and protocol CT colonography (VC) studies		S		A=33% B=66% C=00%
c	Perform and protocol routine relevant CT and MRI imaging studies	R1			
d	*Interpret gastrointestinal imaging examinations accurately and safely:*				
	1) plain x-rays	R1			
	2) barium/water soluble contrast screening studies	R1			
	3) ultrasound	R1			
	4) endoscopic ultrasound		R2		
	5) CT	R1			
	6) Dual Energy CT (DECT)		R2		
	7) CT colonography		R1		
	8) MRI	R2			
	9) MR enterography and enteroclysis		R1		
e	Write clear, accurate and succinct reports	R1			
f	Be able to discuss complex cases with referring clinicians and colleagues	R1			
g	Advise on the most appropriate imaging modality for a given problem	R1			
h	Perform ultrasound guide FNAs of liver lesions	R4			
i	Perform ultrasound guided trucut biopsies of the liver and liver lesions		S		A=44% B=55% C=00%
j	Perform image guided ascites tap	S			A=66% B=33% C=00%
k	Perform image guided drainage of intra-abdominal fluid collections and abscesses	S			A=55% B=44% C=00%
l	Perform cholecystostomies		S		A=11% B=55% C=33%

m	Perform percutaneous transhepatic cholangiography		S		A=22% B=66% C=11%
n	Perform percutaneous transhepatic biliary drainage procedures		S		A=22% B=66% C=11%
o	Perform percutaneous transhepatic biliary stenting procedures		R4		

E – NEPHROLOGY AND UROLOGY IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	*Applied anatomy relevant to radiological diagnosis of urological imaging:*				
	5) normal anatomy	R1			
	6) normal variant anatomy	R2			
b	*The respective roles (including indications) of the following imaging studies in terms of urological imaging:*				
	10) ultrasound investigations	R1			
	11) urological contrast screening studies	R1			
	12) abdomen and pelvis CT	R1			
	13) CT urography	R1			
	14) Dual Energy CT urological applications		R1		
	15) MRI (pelvic)	R2			
	16) prostate MRI		R1		
	17) DTPA / DMSA / MAG III		R1		
c	*The limitations of the following imaging studies in terms of urological imaging:*				
	1) ultrasound investigations	R1			
	2) urological contrast screening studies	R1			
	3) abdomen and pelvis CT	R1			
	4) CT urography	R1			
	5) Dual Energy CT urological applications		R4		
	6) MRI (pelvic)	R2			
	7) prostate MRI		R4		
	8) DTPA / DMSA / MAG III		R4		
d	*The indications, contraindications and complications of the following interventional procedures:*				
	7) imaging-guided renal biopsies (trucut)		R1		
	8) percutaneous nephrostomy		S		A=33% B=55% C=11%
	9) percutaneous nephrolithotomy (PCNL)		S		A=00% B=66% C=33%
	10) transarterial catheter-directed renal embolisation		R1		
	11) tunnelled dialysis catheter placement		R1		
	12) AV fistula for dialysis		R1		
e	*Renal dialysis:*				
	7) indications		R3		
	8) various forms of dialysis		R3		
	9) complications associated with peritoneal dialysis		R1		
	10) imaging of AV fistula and complications of AV fistula		R1		
f	*Renal transplant:*				
	7) role of imaging in the workup to renal transplant - donor	R2			
	8) role of imaging in the workup to renal transplant - recipient	R2			
	9) imaging of complications following transplant		S		A=33% B=55% C=11%
	10) follow up after transplant		S		A=33% B=55% C=11%

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
2 - By the end of the registrar training period a candidate should be able to:					
a	*Perform a range of urological contrast screening studies:*				
	1) MCUG (micturating cystourethrogram)	R1			
	2) IVP (intravenous pyelogram)	R1			
	3) retrograde urethrogram	R1			
b	Perform and protocol routine relevant CT imaging studies	R1			
c	Perform and protocol routine relevant MRI imaging studies	R1			
d	*Interpret renal and urological imaging examinations accurately and safely:*				
	1) plain x-ray	R1			
	2) water soluble contrast screening studies	R1			
	3) various urological ultrasounds	R1			
	4) abdomen and pelvis CT	R1			
	5) CT urography	R1			
	6) Dual Energy CT urological applications		R2		
	7) MRI prostate		R3		
e	Write clear, accurate and succinct reports	R1			
f	Be able to discuss complex cases with referring clinicians and colleagues	R1			
g	Advise on the most appropriate imaging modality for a given problem	R1			
h	Perform percutaneous nephrostomies		S		A=44% B=55% C=00%
i	Perform image guided renal biopsies (trucut)		R4		
j	Perform image guided percutaneous intraperitoneal abscess drainage	R1			

F – GYNAECOLOGICAL IMAGING

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
1- By the end of the registrar training period a candidate should have knowledge of:					
a	*Applied anatomy relevant to radiological diagnosis of gynaecological imaging:*				
	5) normal anatomy	R1			
	6) normal variant anatomy	R2			
b	*The respective roles (including indications) of the following imaging studies in terms of gynaecological imaging:*				
	13) transabdominal gynaecological ultrasound	R1			
	14) endovaginal gynaecological ultrasound		R4		
	15) hysterosalpingography (HSG)	R4			
	16) defecography		R1		
	17) abdomen and pelvis CT	R1			
	18) MRI pelvis	R2			
	19) MR defecography		R2		
c	*The limitations of the following imaging studies in terms of gynaecological imaging:*				
	1) transabdominal gynaecological ultrasound	R2			
	2) endovaginal gynaecological ultrasound		R4		

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
	3) hysterosalpingography (HSG)		S		A=44% B=55% C=00%
	4) defecography		R3		
	5) abdomen and pelvis CT	R1			
	6) MRI	R2			
	7) MR defecography		R2		
d	The indications for uterine artery embolization (UAE)		S		A=11% B=66% C=22%
e	The contraindications of uterine artery embolization (UAE)		S		A=11% B=66% C=22%
f	The complications of uterine artery embolization (UAE)		S		A=22% B=55% C=22%
g	Radiological follow-up after uterine artery embolization (UAE)		S		A=11% B=66% C=22%

2 - By the end of the registrar training period a candidate should be able to:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	Perform and interpret hysterosalpingograms (HSG)	R1			
b	Perform and interpret defecograms		R3		
c	Perform and protocol routine relevant CT imaging studies	R1			
d	Perform and protocol routine relevant MRI imaging studies	R2			
e	*Interpret gynaecological imaging examinations accurately and safely:*				
	1) plain x-ray	R1			
	2) gynaecological ultrasounds	R1			
	3) abdomen and pelvis CT	R1			
	4) MRI	R1			
	5) MR defecography		R2		
	6) conventional defecograms		R3		
	7) transabdominal pelvis ultrasound	R2			Introduced R2
	8) endovaginal gynaecological ultrasound		R4		Introduced R2
	9) MRI pelvis	R4			Introduced R2
f	Write clear, accurate and succinct reports	R1			
g	Be able to discuss complex cases with referring clinicians and colleagues	R1			
h	Advise on the most appropriate imaging modality for a given problem	R1			
i	Perform uterine artery embolism (UAE)		R4		Introduced R2

G – OBSTETRIC IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	The use of intravenous iodated contrast medium in a pregnant patient	R1			
b	Imaging of a pregnant patient with suspected pulmonary embolism	R1			
c	Imaging of a pregnant patient with acute abdominal pain	R1			
d	Imaging of a pregnant patient with vaginal bleeding	R4			
e	*The role of different imaging modalities in pregnant patients:*				
	9) plain x-rays	R1			
	10) ultrasound	R1			

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
	11) CT	R4			
	12) MRI	R4			
	13) nuclear medicine		S		A=11% B=66% C=33%

2 - By the end of the registrar training period a candidate should be able to:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	Advise on the most appropriate imaging modality for a given clinical problem in relation to a pregnant patient	R1			
b	Perform transabdominal obstetric ultrasounds for confirmation of pregnancy and/or foetal viability	R1			
c	Perform transabdominal first trimester obstetric ultrasounds	S			A=66% B=33% C=00% AIUM guidelines removed R2
d	Perform transvaginal first trimester obstetric ultrasounds		R4		AIUM guidelines removed R2
e	Perform second or third trimester obstetric ultrasounds		R3		AIUM guidelines removed R2

H – NEUROLOGICAL IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	The applied anatomy relevant to spinal and cranial imaging	R1			
b	MRI physics	R4			
c	*Different MRI contrast media:*				
	1) how it works	R2			
	2) indications	R2			
	3) side effects	R2			
	4) complications	R2			
d	*The respective roles (including indications) of the following imaging studies in terms of neuroimaging:*				
	1) MRI including MR Angiography	R2			
	2) MR spectroscopy		R4		
	3) CT and cerebral CT Angiography	R2			
	4) CT perfusion imaging		R4		
	5) MR perfusion imaging		R4		
	6) MR functional imaging		R3		
	7) conventional myelography	S			A=55% B=44% C=00%
	8) CT myelography	S			A=66% B=33% C=00%
	9) spinal arteriography		R1		
	10) neuronavigation imaging		R1		
	11) CT cisternography		R1		
	12) radionuclide cisternography		R1		
	13) catheter directed 4 or 6 vessel angiography		R4		
e	*The respective limitations of the following in terms of neuroimaging:*				
	1) MRI including MR Angiography	R2			
	2) MR spectroscopy		R4		
	3) CT and cerebral CT Angiography	R2			
	4) CT perfusion imaging		R4		
	5) MR perfusion imaging		R4		
	6) MR functional imaging		R4		

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
	7) conventional myelography and CT myelography	S			A=55% B=44% C=00%
	8) spinal arteriography		R3		
	9) neuronavigation imaging		R1		
	10) CT cisternography		R3		
	11) radionuclide cisternography		R3		
	12) catheter directed 4 or 6 vessel angiography		R4		
f	*Acute ischaemic cerebrovascular incidents:*				
	1) diagnostic imaging	R1			
	2) treatment		R1		
	3) role of radiology in the treatment		R4		
	4) radiological appearance at follow up	R2			
g	*Intracranial aneurysm rupture:*				
	1) diagnostic imaging (including the role of the various modalities)	R1			
	2) treatment		R1		
	3) the role of radiology in the treatment		S		A=33% B=66% C=00%
	4) follow-up imaging	R2			

2 - By the end of the registrar training period a candidate should be able to:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	Interpret emergency CT of the head	R1			
b	Interpret emergency MRI of the head	R1			
c	Interpret emergency radiographs of the spine	R1			
d	Interpret emergency CT of the spine	R1			
e	Interpret emergency MRI of the spine	R1			
f	Interpret routine CT imaging of the head	R1			
g	Interpret routine MRI imaging of the head	R1			
h	Interpret routine CT imaging of the spine	R1			
i	Interpret routine MRI imaging of the spine	R1			
j	*Perform and/or interpret neurological imaging studies for example:*				
	1) routine MRI brain and spine studies including MR Angiography	R1			
	2) MR spectroscopy		S		A=33% B=66% C=00%
	3) routine CT brain and spine studies including cerebral CT Angiography	R1			
	4) CT perfusion imaging		R3		
	5) MR diffusion imaging	S			A=66% B=33% C=00% Diffusion replaced perfusion R2
	6) conventional myelography	S			A=66% B=33% C=00%
	7) CT cisternography		R2		
	8) catheter directed 4 or 6 vessel angiography		S		A=33% B=66% C=00%
	9) perform image guided lumber punctures and myelography	S			A=55% B=44% C=00%
	10) paediatric cranial ultrasounds	R2			
	11) CT myelography	S			A=66% B=33% C=00% Split from j6 R2
	12) MR functional imaging		R3		Introduced R2
k	Write clear, accurate and succinct reports	R1			
l	Be able to discuss complex cases with referring clinicians and colleagues	R1			
m	Advise on the most appropriate imaging modality for a given problem	R1			

I – EXTRACRANIAL HEAD AND NECK IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNECASSARY	COMMENTS
a	*The applied anatomy relevant to head and neck imaging:*				
	9) normal anatomy	R1			
	10) normal variant anatomy	R2			
b	*The respective roles (including indications) of the following imaging studies in terms of head and neck imaging:*				
	17) plain x-rays	R1			
	18) barium/water soluble contrast screening studies	R1			
	19) video fluoroscopy (swallowing)	R2			
	20) ultrasound	R2			
	21) CT and CT Angiography	R1			
	22) MRI	R2			
	23) MR sialography		R3		
	24) sialography		S		A=44% B=55% C=00%
	25) dacrocystography		R4		
c	*The limitations of the respective imaging studies in terms of head and neck imaging:*				
	1) plain x-rays	R2			
	2) barium/water soluble contrast screening studies	R2			
	3) video fluoroscopy (swallowing)	R2			
	4) ultrasound	R2			
	5) CT and CT Angiography	R2			
	6) MRI	R2			
	7) MR sialography		R3		
d	The management of thyroid nodules	R2			
e	The role (principles, limitations and indications) of MIBG studies in Head and Neck Imaging		R4		
f	The role (principles, limitations and indications) of Octreotide in Head and Neck Imaging		R4		
g	The role (principles, limitations and indications) of PET Scanning in Head and Neck Imaging		R1		

2 - By the end of the registrar training period a candidate should be able to:

		ADVANCED	BASIC	UNECASSARY	COMMENTS
a	*Perform and/or interpret imaging studies relevant to head and neck imaging for example:*				
	1) plain x-rays	R1			
	2) barium/water soluble contrast screening studies	R1			
	3) video fluoroscopy (swallowing)	R1			
	4) sialography	R1			
	5) dacrocystography		R4		
	6) ultrasound	R1			
	7) CT and CT Angiography	R1			
	8) MRI	R1			

	9) MR sialography and dacrocystography		R4		
	10) nuclear studies		R3		
b	Write clear, accurate and succinct reports	R1			
c	Be able to discuss complex cases with referring clinicians and colleagues	R1			
d	Advise on the most appropriate imaging modality for a given problem	R1			
e	Perform ultrasound-guided thyroid FNAs	S			A=66% B=33% C=00%
f	Perform ultrasound-guided FNAs of neck nodes or masses	R4			
g	Perform ultrasound-guided parathyroid ethanol ablation			R3	
h	Perform fluoroscopic sialography		S		A=44% B=55% C=00%
i	Perform dacryocystography		R4		

J – MUSCULOSKELETAL IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	*The applied anatomy relevant to musculoskeletal imaging:*				
	5) normal anatomy	R1			
	6) normal variant anatomy	R2			
b	Terminology relevant to musculoskeletal imaging	R2			
c	The principles of bone and joint lesion characterisation	R1			
d	*The respective roles (including indications) of the following imaging studies in terms of musculoskeletal imaging:*				
	13) plain x-rays	R1			
	14) arthrography	R2			
	15) ultrasound	R2			
	16) CT	R1			
	17) MRI	R1			
	18) MR arthrography	R2			
	19) nuclear studies – bone scans and PET scans		R1		
	20) bone densitometry	S			A=55% B=44% C=00%
e	*The limitations of these imaging studies in terms of musculoskeletal imaging:*				
	1) plain x-rays	R1			
	2) arthrography	R2			
	3) ultrasound	R2			
	4) CT	R1			
	5) MRI	R1			
	6) MR arthrography	R2			
	7) nuclear studies – bone scans and PET scans		R4		
	8) bone densitometry	S			A=55% B=44% C=00%
f	The post-surgical appearance of various common orthopaedic surgery procedures on follow-up imaging	R2			
g	The radiological appearance of complications related to various common orthopaedic procedures	R2			
h	Imaging of orthopaedic prostheses	R2			
i	*Scoliosis:*				
	1) aetiology (including classification)	R2			
	2) diagnostic imaging (including the role of various modalities)	R2			
	3) treatment		R3		
	4) follow-up imaging	R2			
j	*Rheumatology:*				
	3) the role of ultrasound in rheumatology		R3		

		ADVANCED	BASIC	UNECASSARY	COMMENTS
	4) the role of MRI in rheumatology	R2			

2 - By the end of the registrar training period a candidate should be able to:

		ADVANCED	BASIC	UNECASSARY	COMMENTS
a	Interpret plain x-rays	R1			
b	Interpret bone densitometry	S			A=55% B=44% C=00%
c	*Perform and interpret musculoskeletal ultrasound of the*				
	9) shoulder	R1			
	10) ankle		R4		
	11) knee		R4		
	12) wrist		R4		
	13) hip		S		A=33% B=66% C=00%
	14) soft tissue masses	R1			
	15) muscles and tendons		S		A=33% B=66% C=00%
	16) joints in the hands (rheumatology)		R3		
d	Protocol and interpret relevant CT imaging studies	R1			
e	Protocol and interpret relevant MRI imaging studies	R2			
f	Write clear, accurate and succinct reports	R1			
g	Be able to discuss complex cases with referring clinicians and colleagues	R1			
h	Advise on the most appropriate imaging for a given problem	R1			
i	Perform ultrasound-guided fluid (joint) aspiration	S			A=55% B=44% C=00%
j	Perform image-guided bone biopsies		R1		
k	Perform soft tissue biopsies	S			A=55% B=44% C=00%
l	Perform arthrography	S			A=66% B=33% C=00%
m	Perform therapeutic joint injections		S		A=11% B=66% C=22%
n	Perform therapeutic soft tissue injections		S		A=11% B=66% C=22%
o	Perform vertebroplasty			S	A=00% B=33% C=66%
p	Perform discography			S	A=00% B=44% C=55%

K - PAEDIATRIC IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNECASSARY	COMMENTS
a	*The anatomy relevant to paediatric imaging:*				
	5) normal anatomy	R1			
	6) normal variant anatomy	R2			
b	*Age related anatomical changes especially in*				
	9) urogenital imaging	R3			
	10) neuroimaging	R3			
	11) musculoskeletal imaging	R4			
	12) cardiac imaging		S		A=33% B=66% C=00%
c	Radiation safety dosimetry	R2			
d	Dose reduction in relation to paediatric diagnostic imaging	R2			
e	ALARA principles for modalities using ionizing radiation	R2			
f	Practice-based imaging guidelines and appropriateness criteria (e.g. the ACR Appropriateness Criteria and Practice Guidelines)	R2			

g	*The respective roles (including indications) of the following imaging studies in terms of paediatric imaging:*				
	10) plain x-rays	R1			
	11) contrast screening studies	R1			
	12) ultrasound	R1			
	13) CT	R1			
	14) MRI	R1			
h	*The limitations of the following in terms of paediatric imaging:*				
	1) plain x-rays	R1			
	2) contrast screening studies	R1			
	3) ultrasound	R1			
	4) CT	R1			
	5) MRI	R1			
i	The role (including principles, limitations and indications) of MIBG in paediatric imaging		R3		
j	The role (including principles, limitations and indications) of Octreotide Scanning in paediatric imaging		R3		
k	The role (including principles, limitations and indications) of PET Scans in paediatric imaging		R3		
l	The role (including indications and limitations) of nuclear medicine GIT bleeding studies in paediatric imaging		R3		
m	The role (including indications and limitations) DTPA / DMSA / MAG III in paediatric imaging		S		A=22% B=66% C=11%
n	The role (including indications and limitations) Meckels scans in paediatric imaging		S		A=22% B=66% C=11%
o	*Non accidental injury:*				
	1) diagnostic imaging	R1			
	2) management of NAI		S		A=33% B=55% C=00%
	3) role of the radiologist	R1			
2 - By the end of the registrar training period a candidate should be able to:					
		ADVANCED	**BASIC**	**UNNECASSARY**	**COMMENTS**
a	Interpret plain x-rays	R1			
b	*Perform and interpret paediatric ultrasounds for example:*				
	15) general abdominal and pelvic ultrasounds	R1			
	16) renal ultrasound (renal, bladder and pelvis)	R2			Changed wording R2
	17) hip ultrasound	R2			
	18) cranial ultrasound (neonatal head ultrasound)	R2			
	19) ultrasound for pyloric stenosis	R2			
	20) scrotal ultrasound	R2			
	21) ultrasound of the spinal cord		R4		
c	*Perform and interpret paediatric screening studies for example:*				
	1) upper GI study with small bowel series	R2			Changed wording R2
	2) barium enema (including anorectal malformation studies)	R2			Changed wording / combined 2 R2
	3) cystograms	R1			
	4) reduction of intussusception	R1			
	5) oesophagram	R2			Changed wording R2
d	Protocol and interpret relevant MRI and CT imaging studies	R2			
e	Write clear, accurate and succinct reports	R1			

f	Be able to discuss complex cases with referring clinicians and colleagues	R1			
g	Advise on the most appropriate imaging for a given problem	R1			
h	Take a leading role in multidisciplinary paediatric meetings		R4		

L – VASCULAR IMAGING

1- By the end of the registrar training period a candidate should have knowledge of:

		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	*The vascular anatomy of all organs and peripheral circulation:*				
	5) normal anatomy	R1			
	6) normal variant anatomy	R2			
b	*The anatomy relevant to imaging examinations of:*				
	15) gastrointestinal tract	R1			
	16) trauma	R1			
	17) peripheral vascular disease	R1			
	18) cerebrovascular disease	R1			
	19) aorta	R1			
	20) dialysis access		R3		
	21) veins and vena cava	R1			
c	Peripheral vascular disease including the role of imaging	R2			
d	Peripheral vascular disease - the medical, surgical and interventional management options		R3		
e	*Aorta aneurysms:*				
	6) diagnostic imaging	R1			
	7) management		R4		
	8) endovascular repair		R4		
	9) follow up imaging		R4		
f	*The respective roles (including indications) of the following imaging studies in terms of vascular imaging:*				
	1) plain x-rays	R1			
	2) catheter directed arteriography	R2			
	3) ultrasound		R4		
	4) CT including CTA	R2			
	5) MRI including MRA	R2			
g	*The limitations of the following imaging studies in terms of vascular imaging:*				
	1) plain x-rays	R1			
	2) catheter-directed arteriography	R2			
	3) ultrasound	R2			
	4) CT including CTA	R2			
	5) MRI including MRA	R2			
h	*The role (including indications, contraindications, limitations and complications) of the various interventional procedures:*				
	9) percutaneous transluminal angioplasty (PTA)		R3		
	10) peripheral vascular stenting		R3		
	11) endovascular aneurysm repair of the aorta (EVAR)		R4		
	12) inferior vena cava filter placement		R4		
	13) vascular access		R4		
	14) placement of central lines		S		A=33% B=55% C=11%
	15) embolotherapy		R4		
	16) catheter-directed thrombolysis		R3		

2 - By the end of the registrar training period a candidate should be able to:		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	Interpret plain x-rays	R1			
b	*Perform and interpret the following catheter directed angiography:*				
	1) aortagram	R1			
	2) outflow (lower limbs)	R1			
	3) outflow (upper limbs)	R1			
	4) aorta arch and neck vessels	R1			
	5) cerebral 4-vessel	R1			
	6) mesenteric angiography	R1			
	7) pelvic arteriography	R1			
	8) venogram of the upper limbs	R2			
	9) venogram of the lower limbs	R2			
	10) venogram of the vena cava	R2			
c	*Perform the following interventional procedures:*				
	1) peripheral vascular angioplasty		R3		
	2) peripheral vascular stenting		R3		
	3) renal artery angioplasty		R3		
	4) renal artery stenting		R3		
	5) inferior vena cava filter insertion		R4		
	6) basic embolotherapy		R3		
	7) catheter directed thrombolysis		R3		
d	*Perform and interpret vascular ultrasound:*				
	1) ultrasound of the lower limbs for deep vein thrombosis	R1			
	2) carotid ultrasound	S			A=77% B=33% C=00% Not included R2, R3 or R4
	3) ultrasound evaluation of abdominal aorta aneurysm	R1			
	4) ultrasound follow-up of abdominal aorta aneurysm	R1			
	5) renal arterial ultrasound	R2			
e	Perform ultrasound guided insertion of central lines		R4		
f	Protocol and interpret relevant MRA and CTA imaging studies	R1			
g	Write clear, accurate and succinct reports	R1			
h	Be able to discuss complex cases with referring clinicians and colleagues	R1			
i	Advise on the most appropriate imaging for a given problem	R1			
j	Take a leading role in multidisciplinary vascular meetings		R4		

M – NON RADIOLOGICAL SKILLS

1- By the end of the registrar training period a candidate should have knowledge of:		ADVANCED	BASIC	UNNECASSARY	COMMENTS
a	Research principles		R1		
b	Good practise in research		R1		
c	The concept of medical professionalism	R2			

d	The role and interaction of the relevant professional bodies		R1		
e	The principles of good communication	R2			
f	Conflict resolution techniques	R2			
g	The procedure of consenting procedures	R2			
h	Child protection legislation		R4		
i	Discrimination		R3		
j	The basic rights of patients	R2			
k	Constructing meaningful reports	R2			
l	Organisational skills		R1		
m	Time management		R1		
n	Delegation skills		R1		
o	The use of sedation (both in adults and children)		R1		
p	The use of analgesia (both in adults and children)		R1		
q	Breaking bad news		R1		
r	The action required in case of a needle stick injury	S			A=66% B=33% C=00%
s	Infection control		R4		
t	The appropriate use of personal protection equipment	R2			
u	Media awareness and public communications		R1		
v	Principles of medical ethics	S			A=55% B=44% C=00%
w	Patient confidentiality	R2			
x	Communicable disease notification		R4		
y	The principles of evidence-based medicine	R2			
z	The critical appraisal of evidence and articles	R2			
za	The use of computer technology in modern-day radiology	R2			

2 - To what extent should the registrar receive formal education in the following?

		ESSENTIAL	OPTIONAL	UNNECASSARY	COMMENTS
a	Research principles	R2			
b	Good practise in research	R2			
c	The concept of medical professionalism	R3			
d	The role of the relevant professional bodies		R4		
e	The interaction of the relevant professional bodies		R1		
f	The principles of good communication	R1			
g	Conflict resolution techniques	R2			
h	The procedure of consenting procedures	R1			
i	Child protection legislation	R1			
j	Discrimination	R2			
k	The basic rights of patients	R3			
l	Constructing meaningful reports	R1			
m	Organisational skills	S			A=66% B=33% C=00%
n	Time management	R4			
o	Delegation skills		R1		
p	The use of sedation and analgesia	R2			
q	Breaking bad news	S			A=55% B=33% C=11%
r	The action required in case of a needle stick injury	R1			
s	Infection control	S			A=55% B=44% C=00%
t	The appropriate use of personal protection equipment	R2			
u	Media awareness		R4		
v	Public communication		R4		
w	Principles of medical ethics	R1			
x	Patient confidentiality	R1			
y	Communicable disease notification		R4		
z	The principles of evidence-based medicine	R4			
za	The critical appraisal of evidence and articles	R2			
zb	The use of computer technology in-modern day radiology	R1			

DELPHI QUESTIONNAIRE CONSENSUS DOCUMENT

SECTION TWO

Guide to Colour coding used in this table

Indicates consensus achieved during round one	Indicates consensus achieved during round three
Indicates consensus achieved during round two	Indicates consensus achieved during round four

A - FLUOROSCOPY

1 - A registrar should achieve this skill during the

	Likert scale changed R3 Previous options A and B now fall under option A Previous option C now falls under option B Option C has remained unchanged	FIRST HALF	SECOND HALF	NOT NECESSARY	COMMENTS
a	*Knowledge of fluoroscopic image acquisition including:*				
	1) image intensification	R1			
	2) flat panel detectors	R1			
	3) digital fluoroscopy	R1			
	4) digital subtraction techniques	R1			
	5) digital image processing	R1			
b	Knowledge of the various contrast media used in the procedures	R1			
c	Knowledge of radiation considerations associated with screening procedures (especially in children)	R1			
d	*Perform and interpret various procedures:*				
	1) barium swallow	R1			
	2) barium meal	R1			
	3) barium follow through / enteroclysis	R3			
	4) barium enema	R1			
	5) tracheoesophageal fistula (TOF) study		S		A=33% B=66% C=00%
	6) intravenous urogram (IVU or IVP)	R1			
	7) urethrogram	R1			
	8) cystogram	R1			
	9) micturating cysto-urethrogram (MCUG or VCUG)	R1			
	10) hysterosalpingogram (HSG)	S			A=66% B=33% C=00%
	11) defecogram		S		A=11% B=66% C=22%
	12) pneumatic or barium intussusception reduction		R4		
	13) dacrocystogram		S		A=22% B=66% C=11%
	14) sialogram		R4		
	15) arthrogram – shoulder		R3		
	16) myelogram	S			A=55% B=44% C=00%
	17) breast ductogram / galactogram		R4		
	18) diaphragm screening	R1			

B - ULTRASOUND

1 - A registrar should achieve this skill during the

		FIRST HALF	SECOND HALF	NOT NECESSARY	COMMENTS
a	FAST ultrasound	R3			
b	Assessment of abdominal viscera	R1			
c	Transabdominal pelvic ultrasound	R3			Changed wording R2

d	Scrotal ultrasound	R3			
e	Vascular ultrasound of the kidney		R3		
f	Ultrasound of transplanted kidney		R4		
g	Ultrasound evaluation of abdominal aorta aneurysm	R3			
h	Ultrasound evaluation of abdominal aorta aneurysm repair		R3		
i	Transabdominal ultrasound for confirmation of pregnancy	R3			
j	Transabdominal obstetric ultrasound - first trimester	R2			AIUM guidelines removed R2
k	Transabdominal obstetric ultrasound - second trimester		R3		AIUM guidelines removed R2
ka	Transabdominal obstetric ultrasound - third trimester		R4		AIUM guidelines removed R2 Divide 2nd and 3d trimester R2
l	Endovaginal ultrasound for confirmation of pregnancy		R4		
m	Endovaginal obstetric ultrasound - first trimester		R4		AIUM guidelines removed R2
n	Endovaginal obstetric ultrasound - second trimester		S		A=00% B=55% C=44%
na	Endovaginal obstetric ultrasound - third trimester		S		A=00% B=55% C=44% AIUM guidelines removed R2 Divide 2nd and 3d trimester R2
o	Ultrasound for pleural effusion	R3			
p	Ultrasound for pericardial effusion	R4			
q	Extracranial cerebrovascular ultrasound		R3		
r	Thyroid and parathyroid ultrasound		S		A=44% B=55% C=00%
s	Ultrasound of the neck including the salivary glands		S		A=44% B=55% C=00%
t	Transcranial Doppler		R4		
u	Peripheral venous ultrasound of the lower extremities		S		A=33% B=66% C=00%
v	Peripheral venous ultrasound of the upper extremities	R2			
w	Peripheral arterial ultrasound of the lower extremities		R3		
x	Peripheral arterial ultrasound of the upper extremities		R3		
y	*Musculoskeletal ultrasound:*				
	1) shoulder		R3		
	2) elbow		R3		
	3) wrist and hand		R1		
	4) hip		R1		
	5) knee		R3		
	6) ankle		R3		
	7) foot		R3		
	8) soft tissue mass		R3		
z	Rheumatology ultrasound of the hand joints		R3		
za	Orbital ultrasound		R4		
zb	*Paediatric ultrasound investigations such as:*				
	1) abdominal ultrasounds (includes identification of intussusception, pyloric stenosis and appendicitis)	R4			Introduced R2
	2) renal ultrasound (renal, bladder and pelvis)	R3			Introduced R2
	3) transabdominal pelvis ultrasound	R3			Introduced R2
	4) hip ultrasound	R2			Wording changed R2
	5) cranial ultrasound (neonatal head ultrasound)	R2			Wording changed R2
	6) scrotal ultrasound	R2			Introduced R2
	7) ultrasound of the neck	R2			Wording changed R2
zc	*Perform ultrasound guided procedures:*				
	1) ultrasound-guided vascular access		R3		
	2) ultrasound-guided FNA thyroid nodule or mass		R4		
	3) ultrasound-guided FNA liver lesion		R3		
	4) ultrasound-guided core biopsy liver lesion		R3		
	5) ultrasound-guided FNA kidney lesion		R3		
	6) ultrasound-guided core biopsy kidney lesion		R4		
	7) ultrasound-guided biopsy soft tissue mass		R4		

		FIRST HALF	SECOND HALF	NOT NECESSARY	COMMENTS
	8) ultrasound-guided pleural fluid aspiration		R3		
	9) ultrasound-guided intraperitoneal fluid aspiration		R4		
	10) ultrasound-guided percutaneous abscess drainage		R3		
	11) ultrasound-guided pericardial fluid aspiration		R4		

C - COMPUTED TOMOGRAPHY (CT)

1 - A registrar should achieve this skill during the

		FIRST HALF	SECOND HALF	NOT NECESSARY	COMMENTS
a	*Knowledge of the technical aspect and principles of CT scanning including:*				
	1) scanner geometry	R1			
	2) image reconstruction and display	R1			
	3) image quality	R1			
	4) artefacts	R1			
	5) CT dose considerations	R1			
	6) CT fluoroscopy		S		A=33% B=55% C=00%
	7) basic technical and radiation dose considerations	R1			
b	Knowledge of the principles of dual energy CT (DECT)		S		A=33% B=66% C=00%
c	Knowledge of the technical aspects of dual energy CT (DECT)		S		A=33% B=66% C=00%
d	Knowledge of the application of dual energy CT (DECT)		R4		
e	Protocol and interpret commonly performed (basic) CT imaging studies	R3			
f	*Protocol and interpret more specialised CT imaging studies:*				
	1) cardiac CT Angiography		R1		
	2) CT lung perfusion for pulmonary embolism (DECT)		R3		
	3) CT brain perfusion (Dual Energy CT)		R3		
	4) CT colonography		R1		
g	Perform CT myelography	S			A=66% B=33% C=00%
h	Perform CT cisternography		R3		
i	Perform CT-guided lung core biopsies		R3		
j	Perform CT-guided vertebral biopsies		S		A=00% B=66% C=33%
k	Perform uncomplicated CT-guided percutaneous abscess drainage	R2			
l	*Knowledge of iodated contrast media:*				
	1) indications	R1			
	2) contraindications	R1			
	3) side effects	R1			
	4) complications	R1			
	5) prevention of complications	R1			
	6) management of complications	R1			

D - MAGNETIC RESONANCE IMAGING (MRI)

1 - A registrar should achieved this skill during the

		FIRST HALF	SECOND HALF	NOT NECESSARY	COMMENTS
a	*Knowledge of the technical aspect and principles of MRI:*				

	1) magnets	R1			
	2) gradient coils	R1			
	3) RF coils	R1			
	4) functional MRI		S		A=33% B=55% C=11%
	5) magnetic susceptibility	R1			
	6) nuclear magnetic moments	R1			
	7) effect of external magnetic field	R1			
	8) nuclear precession	R1			
	9) equilibrium magnetisation	R1			
	10) significance of radio frequency (RF) pulse	R1			
	11) resonance & Larmor frequency	R1			
	12) free induction decay (FID)	R1			
	13) chemical shift	R1			
	14) relaxation	R1			
	15) pulse sequences	R1			
	16) production of the image	R1			
	17) image quality	R1			
	18) hazards and bio-effects	R1			
	19) fat suppression and fat imaging	R1			
	20) magnetic resonance spectroscopy (MRS)		S		A=33% B=66% C=00%
	21) contrast imaging	R1			
	22) flow effects	R1			
	23) hybrid MR-PET		S		A=22% B=66% C=11%
b	*Protocol and interpret routinely performed MRI imaging studies:*				
	1) MRI brain	R1			
	2) MRI spine	R1			
	3) MRCP		R3		
	4) musculoskeletal MRI (bone and soft tissue tumours and infections)		R3		
	5) musculoskeletal MRI (including wrist, shoulder, hip, knee and ankle)		R3		
	6) MRI pelvis (including prostate, rectum and gynaecological imaging)		R3		
c	*Protocol and interpret more specialised MRI imaging studies:*				
	1) MR spectroscopy		R1		
	2) Functional MRI		R3		
	3) MR enterography		R3		
	4) MR heart		R1		
d	Perform and interpret shoulder MR arthrography		R3		
e	*Knowledge of MR contrast media:*				
	1) indications	R1			
	2) contraindications	R1			
	3) complications	R1			
	4) prevention of complications	R1			
	5) management of complications	R1			

E - BREAST IMAGING

1 - A registrar should achieve this skill during the

		FIRST HALF	SECOND HALF	NOT NECESSARY	COMMENTS
a	*Knowledge of the technical aspects of breast imaging:*				
	9) mechanism of obtaining and optimizing film-screen or digital mammograms	R4			
	10) adjustment of mammography techniques for special cases		R4		
	11) mechanism of obtaining and optimizing breast US		R4		

	12) mechanism of obtaining and optimizing breast MRI		R4		
	13) recognition, understanding, and correction of artefacts in breast		S		A=44% B=55% C=00%
	14) imaging and workstation display of digital mammograms	S			A=66% B=33% C=00%
b	Accurate and safe interpretation of mammograms		R4		
c	Diagnostic breast ultrasound		R4		
d	Perform and interpret tomosynthesis		R3		
e	Accurate and safe interpretation of breast MRI		R2		
f	Perform and protocol breast MRI		R2		
g	*Percutaneous breast biopsy techniques:*				
	1) wire localization		R3		
	2) image-guided core biopsy		R1		
	3) vacuum-assisted biopsy		R3		
	4) image-guided fine needle aspiration		R1		
	5) galactography / ductography		R4		
	6) image-guided cyst aspiration		R3		
h	Understand the principles of population screening	R2			
i	Understand the principles maintaining quality assurance of a screening programme	R2			
j	*Knowledge of other imaging studies relevant to breast imaging:*				
	1) PET CT		R2		
	2) elastography		R3		
	3) tomosynthesis		R3		

F - INTERVENTIONAL RADIOLOGY

1 - A registrar should achieve this skill during the

		FIRST HALF	SECOND HALF	NOT NECESSARY	COMMENTS
a	Knowledge of radiation considerations associated with interventional procedures and radiation protection	R3			
b	Basic knowledge of diagnostic catheters	S			A=66% B=33% C=00%
c	Basic knowledge of drainage catheters	R1			
d	Basic knowledge of mechanical embolisation agents	R2			
e	Basic knowledge of vascular stents and IVC filters	S	S		A=44% B=44% C=11%
f	*Knowledge of various interventional procedures (including their role, indications, contraindications and complications):*				
	1) percutaneous transluminal angioplasty (PTA)		R3		
	2) peripheral vascular stenting		R3		
	3) endovascular aneurysm repair of the aorta (EVAR)		R3		
	4) inferior vena cava filter placement		R3		
	5) vascular access		R4		
	6) placement of central lines		R4		
	7) embolotherapy		R3		
	8) catheter-directed thrombolysis		R3		
	9) imaging guided renal biopsies (trucut)		R4		
	10) percutaneous nephrostomy		R4		
	11) percutaneous nephrolithotomy (PCNL)			S	A=00% B=33% C=66%
	12) transarterial catheter-directed renal embolisation		R4		
	13) tunnelled dialysis catheter placement		S		A=00% B=66% C=33%
	14) AV fistula for dialysis		R3		
	15) percutaneous transhepatic cholangiography (PTC)		R4		

	16) percutaneous transhepatic biliary stenting and drainage procedures		R4		
	17) RF ablation of liver lesions		R3		
	18) transarterial catheter-directed chemo embolization (TACE) of hepatic tumours		R2		
	19) percutaneous cholecystostomy		S		A=00% B=66% C=33%
	20) transarterial catheter-directed diagnosis and treatment of gastrointestinal bleeding		R3		
	21) liver and pancreas biopsies		R3		
	22) drainage procedures for intra-abdominal fluid collection and abscesses		R4		
	23) uterine artery embolization		R4		
	24) cerebral aneurysm coiling		S		A=00% B=66% C=33%
	25) catheter-directed 4 or 6 vessel angiography		R3		
	26) image-guided lumber punctures and myelography		R4		
	27) ultrasound-guided parathyroid ethanol ablation			S	A=00% B=44% C=55%
	28) vertebroplasty		S		A=00% B=55% C=44%
	29) bronchial artery embolisation		R4		
g	*Perform the following interventional procedures:*				
	1) catheter-directed aortagram	R2			
	2) catheter-directed peripheral arteriography	R2			
	3) catheter-directed mesenteric angiography	R2			
	4) percutaneous transluminal angioplasty (PTA)		S		A=00% B=66% C=33%
	5) peripheral vascular stenting		S		A=00% B=55% C=44%
	6) endovascular aneurysm repair of the aorta (EVAR)			R1	
	7) inferior vena cava filter placement		S		A=00% B=66% C=33%
	8) vascular access		R4		
	9) placement of central lines		R3		
	10) catheter-directed embolotherapy		R4		
	11) catheter-directed thrombolysis		R3		
	12) imaging-guided renal biopsies (trucut)		R4		
	13) percutaneous nephrostomy		R4		
	14) percutaneous nephrolithotomy (PCNL)			R1	
	15) transarterial catheter-directed renal embolisation		R4		
	16) tunnelled dialysis catheter placement		S		A=00% B=66% C=33%
	17) percutaneous transhepatic cholangiography (PTC)		R4		
	18) percutaneous transhepatic biliary stenting and drainage procedures		R3		
	19) RF ablation of liver lesions			R1	
	20) transarterial catheter-directed chemo embolization (TACE) of hepatic tumours			S	A=00% B=44% C=55%
	21) percutaneous cholecystostomy		S		A=00% B=66% C=33%
	22) transarterial catheter-directed diagnosis and treatment of gastrointestinal bleeding		R2		
	23) liver and pancreas biopsies		R3		
	24) drainage procedures for intra-abdominal fluid collection and abscesses	R2			
	25) uterine artery embolization		R4		
	26) cerebral aneurysm coiling			R1	
	27) catheter directed 4 or 6 vessel angiography		R3		
	28) image guided lumber punctures and myelography		R4		
	29) ultrasound guided parathyroid ethanol ablation			R1	
	30) vertebroplasty			R1	
	31) bronchial artery embolisation		R4		
h	**Knowledge** of post-intervention care including pain relief	S			A=66% B=33% C=00%

G - ASSESSMENT SCHEDULE

		AFTER EACH ROTATION	AFTER THE FIRST ROTATION and ONCE AGAIN AT ANY TIME DURING BEFORE THE FINAL EXAMINATION	OTHER - including 'NOT NECESSARY' (PLEASE MOTIVATE YOUR ANSWER)
a	During his/her postgraduate training a registrar should undergo an **ultrasound** assessment	R4		
b	During her/his postgraduate training a registrar should undergo a **CT** assessment	R4		
c	During his/her postgraduate training a registrar should undergo a **MRI** assessment	R4		
d	During her/his postgraduate training a registrar should undergo a **breast imaging** assessment	R4		
e	During his/her postgraduate training a registrar should undergo a **screening/ fluoroscopy** assessment	R4		
f	During her/his postgraduate training a registrar should undergo an **interventional radiology** assessment	R4		
g	During her/his postgraduate training a registrar should undergo a separate **paediatric radiology** assessment	R4		

APPENDIX B1

LETTER OF INVITATION TO PARTICIPATE IN A SEMI-STRUCTURED INTERVIEW

Department Clinical Imaging Sciences
University of the Free State
Bloemfontein
South Africa

Date

Dear (interviewee)

Re: Invitation to Participate in a Semi-structured Interview

I am a Senior Lecturer/Principal Specialist in the Department of Diagnostic Radiology (Clinical Imaging Sciences) at the University of the Free State, Universitas Hospital, and currently enrolled at the UFS for doctoral studies.

For my Ph.D. in Health Sciences Education I am doing a study on Postgraduate Training in Diagnostic Radiology in South Africa (and specifically at the University of the Free State). The title of my thesis is: *A Competency-based Continuous Assessment Programme as part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State* (UFS Ethics Committee approval number – Ecufs no 80/2013).

The **purpose of the research** is to devise a reliable, accurate, reproducible and timely competency-based continuous assessment programme that will allow the formative and progressive evaluation of an individual's progress throughout his/her registrar training. The assessment programme will incorporate predetermined and well-defined learning outcomes – these will be available to the student on entering the postgraduate training programme. This will present the registrar with a blueprint of what is expected of him/her at different stages/levels of their training, effectively guiding them through the postgraduate training period. The assessment programme will serve as the basis for continued assessment – the (accumulative) results of which will determine the candidate's eligibility to sit their final exam. Being formative in nature implies that each assessment will be followed by a (positive) feedback session, which – where necessary – should result in the modification and guidance of further learning in an attempt to correct any inadequacies/incompetence identified at the time of the assessment.

The **relevance of the research** lies in the outcome-based academic guidance it will provide both the candidates and supervisors in order to better train and educate registrars, which in turn will more fully prepare the registrar for their final exams, ensuring a better pass rate and a high qualifying standard on par with international standards.

The **overall goal of the study** is to improve the postgraduate diagnostic radiology training at the UFS (and possibly in South Africa) so that by the time they graduate, registrars are competent clinical imaging specialists, fully capable of safe and effective independent practice.

Because of your expertise and experience in the field of diagnostic radiology I am inviting you to participate in this study. Your involvement will require your participation in a semi-structured interview, to be conducted on a one-on-one basis. The topics under discussion will involve a proposed continued assessment programme for postgraduate training in diagnostic radiology.

A semi-structured interview is a qualitative method of inquiry that combines a pre-determined set of open questions (questions that prompt discussion) with an opportunity for the interviewer to explore particular themes or responses further. The interviewer has a set of pre-planned core questions for guidance, ensuring that the same areas are covered with each interviewee. As the interview progresses, the interviewee has the opportunity to elaborate or provide more information as he/she sees fit. The structure of the interview (or lack thereof) also allows for new questions to be raised during the interview, in response to information provided by the interviewee. Although most of the questions are created during the interview, the pre-planned core questions ensure a degree of consistency across the interviews.

Information gained from the interviews will be used in the development of a continued assessment program for postgraduate radiology training at the University of the Free State.

A time and place for the interview will be arranged at your convenience. Although the interview will likely be concluded within half an hour, you should allow for approximately an hour of uninterrupted free time.

There is no compensation for participating in the interview process, nor is there any known risk.

Participation is strictly voluntary and you may withdraw from this study at any time.

Your participation (and that of all the other participants) is anonymous and no reference will be made to any names, not even on completion and publication of the thesis. Interviews will be recorded in order to ensure accurate record keeping of data and for the purpose of post process analysis; I wish to give you my assurance that all data collected during the course of the research will be treated confidentially at all times.

The data you provide will form the basis of my thesis and will most certainly help shape the future training of radiology registrars at the University of the Free State.

You may contact Ms J du Plessis, Secretariat of the Ethics Committee of the Faculty of Health Sciences, UFS at telephone number (051) 4052812 if you have questions about your rights as a research subject.

The promoters for this PhD study are:

Promoter	**Co-promoter**	**Co-promoter**
Prof (MM) Marietjie Nel Head: Division Health Sciences Education Faculty of Health Sciences NelMM@ufs.ac.za	Prof (GJ) Gert van Zyl Dean: Faculty of Health Sciences University of the Free State vanzylgj@ufs.ac.za	Prof (CS) Coert De Vries Head: Department Clinical Imaging Sciences University of the Free State deVriesC@ufs.ac.za

Should you have any queries or require any further information, please do not hesitate to mail me at naudburg@iclix.co.za or jansevrj@ufs.ac.za. Alternatively you may contact me on 0828903044.

Thank you for considering my request.

Yours faithfully

Dr Jacques Janse van Rensburg M.Med Rad (Diag)
Senior Lecture/Principal Specialist
Department Clinical Imaging Sciences
University of the Free State
Bloemfontein, South Africa

APPENDIX B2

CONSENT FORM: SEMI-STRUCTURED INTERVIEW

I, the undersigned, hereby agree to be a participant in a semi-structured interview as part of the Ph.D. study with the title *A Competency-based Continuous Assessment Programme as Part of a Revised Curriculum for Postgraduate Radiology Training at the University of the Free State* (Ecufs no 80/2013).

As arranged the interview is scheduled to take place ________________________

I am satisfied with the conditions of the interview as stipulated in the letter of invitation that I have received. I understand that my participation in the interview is anonymous and that there will be no references to any names. All data collected during the interview will be treated in a highly confidential manner. I am also of the understanding that I will not be held accountable for any decisions or conclusions emanating from the study. I acknowledge that the results from this research will be published.

My full particulars are:

Title ____

Surname ____

Full names ____

Contact number ____

E-mail address ____

Signature ____________________________ Date ___________

THANK YOU FOR PARTICIPATING IN THIS SEMI-STRUCTURED INTERVIEW

APPENDIX B3

INTERVIEW GUIDE FOR SEMI-STRUCTURED INTERVIEWS

A COMPETENCY-BASED CONTINUOUS ASSESSMENT PROGRAMME AS PART OF A REVISED CURRICULUM FOR POSTGRADUATE RADIOLOGY TRAINING AT THE UNIVERSITY OF THE FREE STATE (Ecufs no 80/2013)

INTERVIEW GUIDE

Purpose of the interview:

The purpose of this semi-structured interview is to gain insight into important key aspects related to the development and implementation of a formal and structured continuous assessment programme for postgraduate radiology training at the University of the Free State. This will be achieved through the academic contributions of experts in the field of postgraduate radiology training, by exploring their attitudes, approaches, feelings and disposition towards important applicable issues, and the possible solutions they have to foreseeable problems.

During the interviews different concepts, related to the development and implementation of a formal and structured continuous assessment programme for postgraduate radiology training, will be critically analysed and discussed, looking for agreement amongst the interviewees and collecting new ideas and constructive criticism for possible assimilation into the final assessment programme.

Forming the basis of the semi-structured interviews is a pre-determined set of open questions (questions that prompt discussion). Whilst this set of questions will ensure that all relevant topics are covered, the format of the semi-structured interview will allow the interviewer the opportunity of exploring particular themes or responses further. The format of the interview further ensures flexibility in the way issues are addressed and allows for the formulation and posing of new questions as a result of what the interviewee says.

Important:

Please study the questions, and formulate your opinions as much as possible, prior to the interview. You are encouraged to make notes in the spaces provided – this may help you in your answers on the day of the interview.

Questions:

1. Which assessment tools, in your opinion, should be included in a formal and structured continuous assessment programme for postgraduate radiology training in South Africa? Please motivate your answer in detail.

   For example (but not limited to):

   - *Mini-Imaging Interpretation Exercise (mini-IPX)*
   - *Radiological Direct Observation of Procedural Skills (Rad-DOPS)*
   - *Teaching Observation (TO)*
   - *Multisource Feedback (MSF)*

2. In your opinion, should the assessment tools be used formatively (i.e. to inform future learning)? Or should it be used summatively (whereby failure to attain a satisfactory assessment can prevent a candidate from advancing)? Please motivate your answers.

3. In your opinion, who should be involved in the assessment of registrars? Please motivate your answer.

   For example (but not limited to):

   - *Consultants from the radiology department*

- *Visiting consultants from other radiology departments*
- *Radiologists in private practice*
- *Consultants from other medical specialist departments such as surgery or cardiology etc.*
- *Sonographers*

4. What are your views on assessors undergoing formal and standardised training in the assessment of registrars? Please motivate your answers.

For example (but not limited to):

- *Formal training of assessors will improve the reliability and quality of registrar assessments.*
- *Formal training of assessors will reduce, or possibly even eliminate, assessor bias.*
- *Assessor training should not be mandatory, but left to the discretion of the individual assessor.*
- *Assessor training is a waste of time and resources.*

5. How would you assign the different assessments? Please motivate your answer.

For example (but not limited to):

- *Distribute the assessments amongst the consultants within a department i.e. any consultant can and may perform any assessment, irrespective of modality or area of expertise.*
- *Assign specific assessments to specific consultant according to modality or area of expertise.*
- *Registrars should be allowed the freedom to choose their assessor.*

6. What, in your opinion, is the most appropriate way to schedule assessments? Please motivate your answer.

   For example (but not limited to):

   - *A rigid assessment schedule which places assessment at the end of a (each) training period (e.g. after each rotation, at the end of each semester or yearly).*
   - *A less formal assessment schedule, which prescribes a requisite number of each assessment per year, allowing the registrar the freedom to choose when an assessment takes place (obviously within the prescribed timeline).*

7. What are the challenges, in your opinion, related to the implementation of a formal and structured continuous assessment programme for postgraduate radiology training in South Africa? Please suggest solutions to the problems as you see them.

   For example (but not limited to):

   - *Consultants are already overburdened and do not have the time for individual feedback sessions with each registrar.*
   - *If the assessment programme prescribes too many assessments it will interfere with registrar's duties.*
   - *Formative assessment prescribes additional aid to underperforming and struggling registrars – such structures are not in place (putting such mechanisms in place poses yet another set of problems).*

8. Given our limited resources in an already overburdened academic environment, what are your views on the viability of such a formal and structured continuous assessment programme for postgraduate radiology training in South Africa? Please motivate your answer.

   For example (but not limited to):

   - *Yes, it is viable and absolutely necessary.*
   - *Assessment in its current form is adequate and we do not need to change anything.*
   - *Such an assessment programme, although necessary, is too labour intensive for the current state of academic radiology in South Africa.*

9. Can you think of any other aspects of such a proposed assessment programme, which has not been addressed during this interview? Which other questions should be included in this interview guide?

THANK YOU FOR YOUR WILLINGNESS TO PARTICIPATE

APPENDIX B4

INFORMATION GUIDE FOR SEMI-STRUCTURED INTERVIEWS

This document provides information on the various assessment tools used in postgraduate radiology training programmes across the world, and the application of the CanMEDS competencies to radiology.

A comprehensive, accurate, valid and reliable assessment of a trainee's competence-based performance requires both high-stakes summative examinations (written and oral examinations employed at the end of a training period for the purpose of accreditation, certification and progression), as well as more formative in-training workplace-based assessments.

The former usually involves written examinations such as multiple choice questions (MCQs), short answer questions (SAQs), script concordance questions, structured essays, and structured oral examinations.

Workplace-based assessments (WpBAs) are designed to assess the day-to-day practices undertaken in the workplace, which gives a better reflection of his or her performance in context. Another strength of workplace-based assessment is its formative *potential*, which is dependent on constructive feedback from the assessor. The inclusion of essential physician competencies (such as the CanMEDS competencies) in postgraduate curricula is commonplace and the ABR, RCR, RANZCR and the Netherlands have all integrated these roles into their respective postgraduate radiology curricula. WpBAs have shown the potential to assess these physician roles (with varying degrees of [proven] reliability and validity).

The accompanying table lists the various assessment methods that are in use in postgraduate radiology training programmes in Australia and New Zealand, USA, UK and the Netherlands. The table also gives an indication of which physician roles each assessment tool is capable of judging. A short description of these assessment methods follows.

Assessment Methods	Direct Observation by an Expert	Standardised Assessment Form	Feedback	CanMEDS Competencies	Dutch	RCR	RANZCR	ABR
Mini-Clinical Evaluation Exercise (mini-CEX)	Y			ME, COM, COL, MAN, HA, SC, PRO	10/YR			
Objective Structured Assessment of Technical Skills (OSATS)	Y			ME, COM, PRO	10/YR			
Mini-Imaging Interpretation Exercise (mini-IPX)	Y	Y	Y	ME, COM, MAN, HA, SC, PRO		6/YR	2/YR	
Radiological Direct Observation of Procedural Skills (Rad-DOPS)	Y	Y	Y	ME, COM, MAN, HA, SC, PRO		6/YR	2/YR*	
Multidisciplinary Teamwork Assessment	Y	Y	Y	ME, COM, HA, PRO		2/YR		
Teaching Observation (TO)	Y	Y	Y	ME, COM, HA, SC		2/YR		
Audit Assessment		Y	Y			1/YR		
Critically Appraised Topics (CATs)		Y	Y	ME, COM, SC	2/YR		2/YR	
In-training Evaluation Report (ITER)	Y **			ME, COM, COL, HA, SC, PRO				
Global Ratings	***	Y						Y
Review of Dictation								Y
Multisource Feedback (MSF)		Y	Y	COM, COL, MAN, HA, SC, PRO	1/YR	1/YR	1/YR	Y
Portfolios			Y	COM, MAN, HA, SC, PRO, COL	Y	Y	Y	Y
Logbooks				ME, COM	Y	Y	Y	Y
Meetings with Programme Director			Y					
Research Component			Y					

ME – medical expert, **COM** – communicator, **COL** – collaborator, **MAN** – manager, **HA** – health advocate, **SC** – scholar, **PRO** – professional

* - 4 in final year
** - informal observations over a period of time informs the completion of an ITER at the end of a period of time
*** - ratings are retrospective, based on general impressions collected over a period of time through various sources

SECTION A

The next few pages provide an explanatory discussion of the assessments methods referred to in the accompanying table.

The **Audit Assessment** tool is designed to assess a trainee's competence in completing an audit. The process should be trainee-led (identifying the audit to be assessed and appropriate assessors). The audit assessment can be based on review of audit documentation or on a presentation of the audit at a meeting. Performance is measured using a standardised rating scale.

A clinical audit is a tool designed to improve the quality of patient care, experience and outcome through formal review of systems, pathways and outcome of care against defined standards, and the implementation of change based on the results. An audit uses specific methodology in which performance is compared with a preselected standard. If the standard is not achieved, reasons for this are explored, change implemented and a re-audit carried out to ensure improvement

Radiological Direct Observation of Procedural Skills (Rad-DOPS) focuses on the core skills that a trainee requires when undertaking a clinical practical procedure. The assessment is based on an assessor's direct observation of a trainee undertaking a clinical practical radiological procedure (e.g. image-guided biopsy, barium examination, ultrasound etc.). The assessor is usually a consultant radiologist with the necessary expertise to assess the specific procedure. A non-radiologist who is a suitable expert in the procedure being assessed, such as a vascular surgeon, vascular technologist, sonographer etc., may also assess the trainee. Performance is measured using a standardised rating scale (the performance of the trainee should be rated against that which the assessor would reasonably expect at the trainee's stage of training and level of experience). The assessor provides the trainee with immediate formative and constructive feedback (in the particular area of diagnostic imaging) upon completion of the assessment (which coincides with completion of the procedure). The process should be trainee led (identifying the activity to be assessed and selecting an appropriate assessor). In an informal arrangement, no specific planning for the observation would be involved and the assessment would not be recorded on a standardised form. The culmination of such informal observations could inform the completion of a summary **In-Training Evaluation Report** (ITER) at the conclusion of the educational experience. An ITER is a single-page report with several (about 15) scales, completed at the end of each 1- or 2-month rotation by a resident's supervisor, often in consultation with others who have worked with the resident. This type of end-of-rotation evaluation suffers from its summative nature, the weakness of delayed recall of performance, and the general reluctance of evaluators to provide negative feedback.

The **Mini-Imaging Interpretation Exercise** (mini-IPX) tool is designed to assess a trainee's skills in interpreting diagnostic medical images for an individual patient. The assessment may be confined to a single imaging examination, or a series of imaging studies that lead to a specific diagnosis. The process should be trainee led (identifying the activity to be assessed and selecting an appropriate assessor). In general however, the assessor should be responsible for selecting a case of appropriate difficulty complexity prior to the assessment. The assessor directly observes the trainee performing the activity in a normal environment. The trainee presents the individual case verbally to the assessor. Performance is measured using a standardised rating scale (the performance of the trainee should be rated against that which the assessor would reasonably expect at the trainee's stage of training and level of experience). The assessor provides the trainee with immediate formative and constructive feedback (in the particular area of diagnostic imaging) upon completion of the assessment.

Critically Appraised Topic (CAT) is a one-page rapid review of an imaging-related peer-reviewed research publication to determine if the study should be taken seriously and where its flaws lie. These can be for the areas of Treatment, Diagnosis and Harm. The critical analysis of the research article involves a step-by-step process aimed at answering a specific research question that arises from a clinical scenario, using a carefully selected and appropriate analysed research article.

Examples of research questions include:

- Deciding if the appraised article has been well-performed.
- Analysing the results presented in the article using a structured methodology.
- Concluding if the article provides believable results.
- Deciding whether such results can and should be translated into clinical practice.

The supervisor is any radiologist involved in the training of the trainee. Assessment is ideally done during the CAT presentation, which is best conducted in a group forum, such as a departmental Journal Club or regular meeting where educational material is presented.

Multi-Source Feedback (MSF) is an assessment of a trainee's clinical performance and professional behaviour within the workplace, performed by a number and variety of assessors. MSF represents a method of assessing generic skills such as communication, leadership, team working and reliability. The assessor should be someone who has reasonably regular and direct interaction with the trainee (in the workplace). Assessors are drawn from four groups of co-workers consisting of other senior clinicians, allied health professionals, administrative or clerical staff and other trainees. The trainee asks the specified number of colleagues and co-workers to independently and anonymously complete a questionnaire in which they judge his or her performance in areas of communication skills, team work, professionalism and management /administrative skills, using a standardised rating scale. Trainees must also complete a self-assessment using the same questionnaire. The two practical challenges are: constructing surveys that are appropriate for use by all evaluators in the circle of influence, and orchestrating data collection from a potentially large number of individuals (between 12 and 15 respondents) that can be compiled and reported confidentially to the resident.

The **Teaching Observation** is designed to provide structured, formative feedback to trainees on their competence at teaching. Teaching Observation can be based on any instance of teaching by the trainee, which has been observed by the assessor. Performance is measured using a standardised rating scale. The assessor provides the trainee with immediate formative and constructive feedback upon completion of the assessment.

The **Multi-Disciplinary Teamwork** (MDT) assessment tool is designed to assess a trainee's ability to contribute effectively to multidisciplinary team working and to assume a leadership role in multidisciplinary meetings. Assessment is based on the assessor observing a trainee in a normal multi-disciplinary meeting. Performance is measured using a standardised rating scale. The assessor provides the trainee with immediate formative and constructive feedback upon completion of the assessment (this should include specific written comments on areas of good practice and constructive feedback on areas for further development). The trainee should lead the process by identifying an assessor and agreeing an appropriate meeting.

Global ratings are distinguished from other forms of rating in that (a) an assessor judges general categories of ability (e.g. patient care skills, medical knowledge, interpersonal and communication skills) instead of specific skills, tasks or behaviours; and (b) the ratings are completed retrospectively based on general impressions collected over a period of time (e.g., end of a clinical rotation) derived from multiple sources of information (e.g., direct observations or interactions; input from other faculty, residents, or patients; review of work products or written materials). Performance is measured using a standardised rating scale to judge knowledge, skills and behaviours listed on the form. Written comments are important to allow evaluators to explain the ratings. Global rating forms are most often used for making end of rotation and summary assessments about performance observed over days or weeks. A number of problems with global ratings have been documented: scores can be highly subjective when raters are not well trained; sometimes all competencies are rated the same regardless of performance; and scores may be biased when raters inappropriately make severe or lenient judgments or avoid using the extreme ends of a rating scale. Training of raters is important to improve reproducibility of the findings.

SECTION B

The next few pages deal with the CanMEDS competencies and how it can be applied to postgraduate radiology training. Each country adapts the CanMEDS competencies to their training programmes needs – the following represents only one of these adaptations (in this case Canada).

1) Medical Expert Role

Definition:
As Medical Experts, physicians integrate all of the CanMEDS Roles, applying medical knowledge, clinical skills, and professional attitudes in their provision of patient-centred care. Medical Expert is the central physician Role in the CanMEDS framework.

How medical expert applies to radiology:
Core knowledge of:

- Formation of radiological images (including physical and technical aspects, patient positioning, contrast media)
- Human anatomy, emphasizing radiological applications
- All aspects of clinical radiology including understanding disease processes, appropriate application of imaging to patients, informed consent, interpretation of imaging studies including appropriate differential diagnoses
- Radiation protection

Show competence in:

- Effective radiologic consultation
- Diagnostic and interpretive skills
- Manual and procedural skills (diagnostic/therapeutic)
- Managing a patient independently during procedures
- Understanding and managing complications

Understand the fundamentals of:

- Quality assurance
- epidemiology,
- biostatistics and

- decision analysis

Assessment tools:

- Written Tests (MCQ and SAQ)
- Oral examination
- Direct observation
- ITER (In-training Evaluation Report)
- OSCE
- Simulation
- MSF
- Essays
- Portfolio

2) Communicator Role

Definition:

As Communicators, physicians effectively facilitate the doctor-patient relationship and the dynamic exchanges that occur before, during, and after the medical encounter.

How communicator applies to radiology:

- Reporting skills (describe the imaging findings, most likely differential diagnoses, and, when indicated, recommend further testing and/or management)
- Understand the importance of communication with referring physicians, including an understanding of when the results of an investigation or procedure should be urgently communicated.
- Informed consent
- Breaking bad news
- Disclosure of error or adverse event
- Appropriate documentation

Assessment tools:

- Direct observation
- ITER
- OSCE
- MSF
- Portfolio

3) Collaborator Role

Definition:

As Collaborators, physicians effectively work within a healthcare team to achieve optimal patient care.

How collaborator applies to radiology:

- Effectively work within a radiology healthcare team (nurses, technologists, support staff)
- Prevent, negotiate, and resolve conflict
- Working with others to assess, plan, provide and review other tasks, such as research problems, educational work, program review or administrative responsibilities
- Demonstrate respect, leadership, etc.

Assessment tools:

- Direct observation
- ITER
- MSF
- OSCE
- Simulation
- Written Tests

4) Manager Role

Definition:

As Managers, physicians are integral participants in healthcare organizations, organizing sustainable practices, making decisions about allocating resources, and contributing to the effectiveness of the healthcare system.

How manager applies to radiology:

- Appropriate allocation of finite healthcare resources
- Time management
- Radiology practice management

- Budgeting and finance
- Leadership
- Physician remuneration
- Administration
- Career development
- Quality assurance
- Information technology
- Participation in committees and meetings

Assessment tools:

- Direct observation
- ITER
- MSF
- Simulation
- Portfolio

5) Health Advocate Role

Definition:

As Health Advocates, physicians responsibly use their expertise and influence to advance the health and well-being of individual patients, communities, and populations.

How health advocate applies to radiology:

- Population screening
- Radiation protection/radiobiology
- Informing patients, colleagues and communities at large about radiation doses from imaging studies
- Contrast use and safety
- Patient safety in the hospital/clinic setting
- Public policy relating to radiology

Assessment tools:

- Direct observation
- ITER
- MSF
- Essay

- Portfolio
- OSCE
- Written Tests

6) Scholar Role

Definition:

As Scholars, physicians demonstrate a lifelong commitment to reflective learning, as well as the creation, dissemination, application and translation of medical knowledge.

How scholar applies to radiology;

- Personal education strategy
- Maintenance of competence
- Conducting personal practice audits
- Documenting learning
- Critical appraisal
- Critically evaluating medical information and its sources, and applying this appropriately to practice decisions
- Facilitate the learning of patients, families, students, residents, other health professionals (technologists and nurses) and the public relating to imaging
- Research and ethics relating to radiology

Assessment tools:

- Direct observation
- ITER
- Portfolio
- MSF
- Written Tests

7) Professional Role

Definition:

As Professionals, physicians are committed to the health and well being of individuals and society through ethical practice, profession-led regulation, and high personal standards of behaviour.

How professional applies to radiology:

- Exhibit appropriate professional behaviours in practice, including honesty, integrity, commitment, compassion, respect and altruism
- Dealing with ethical issues appropriately
- Participate in peer review
- Manage conflicts of interest
- Appreciate the professional, legal and ethical codes of practice for radiology
- Fulfil the regulatory and legal obligations required of current practice
- Balance personal and professional priorities to ensure personal health and a sustainable practice

Assessment tools:

- Direct observation
- ITER
- MSF
- Portfolio
- Simulation

APPENDIX C1

EXAMPLE OF A RADIOLOGY-DOPS ASSESSMENT FORM

Descriptors of competencies demonstrated during Rad-DOPS.

Demonstrates knowledge of indications, relevant anatomy and technique	Does the registrar know the relevant indications, anatomical landmarks, and techniques relevant to the procedure?
Explains procedure/risks to patient, obtains informed consent where appropriate	Is there a clear explanation of the proposed procedure to the patient, with the patient given an opportunity to ask questions? Where informed consent is sought, is this documented appropriately?
Uses appropriate analgesia or safe sedation	Does the registrar use adequate amounts of appropriate drugs to minimise patient discomfort? Is this titrated where appropriate?
Demonstrates knowledge of equipment and uses equipment appropriately	Does the registrar demonstrate knowledge of the radiology equipment with appropriate tool/probe selection and utilisation? Does he/she optimise equipment parameters for individual examinations?
Aseptic technique	The cleansing of hands and, where relevant, equipment before and after every physical patient episode is mandatory.
Technical ability	Most pertinent to practical applications such as ultrasound, interventions and screening. Is there satisfactory hand/eye co-ordination?
Seeks help if appropriate	Does the registrar recognise his/her limitations and request assistance when appropriate?
Minimises use of ionising radiation as needed	Where the procedure involves ionising radiation.
Quality of diagnostic images	Does the registrar produce images that are relevant and diagnostic?
Communication skills with patient/staff	Is the registrar polite, and exhibits a sense of self within a team structure? Is he / she able to convey understanding to others?
Quality of report of procedure	Does the report have a clear, concise, clinically appropriate and lucid appearance, within the context of other available clinic radiological information?
Judgement and insight	For example, the registrar stops the procedure if unforeseen complications are encountered.

Radiology Direct Observation of Procedural Skills (Rad-DOPS)

Name of Assessor ____________________

Name of Registrar ____________________

Student Number ____________________

Date of Assessment ____________________

Year of training 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Modality / Rotation	Fluoroscopy	Paediatric Imaging	Ultrasound	CT
	Breast Imaging	Interventional	Nuclear Imaging	MRI
	Other			

Name of Procedure ____________________

	Below expectation for stage of training	Meets expectation for stage of training	Above expectation for stage of training	Unable to comment
Demonstrates knowledge of indications, relevant anatomy and technique				
Explains procedure/risks to patient, obtains/confirms informed consent where appropriate				
Uses appropriate analgesia or safe sedation				
Usage of equipment				
Aseptic technique				
Technical ability				
Seeks help if appropriate				
Minimises use of ionising radiation for procedures involving x-rays				
Quality of diagnostic images				
Communication with patients/staff				
Quality of report of procedure				
Judgement and insight				
Unable to comment – Please mark this if you have not observed the behaviour and feel unable to comment.				

Overall Competence		
Rating	Description	
Trainee requires additional support and supervision	Demonstrates basic radiological procedural skills resulting in incomplete examination findings. Shows limited clinical judgement following encounter	
Trainee requires direct supervision	Demonstrates sound radiological procedural skills resulting in adequate examination findings. Shows basic clinical judgement following encounter	
Trainee requires minimal/indirect supervision	Demonstrates good radiological procedural skills resulting in sound examination findings. Shows good clinical judgement following encounter	
Trainee requires very little/no senior input and able to practise independently	Demonstrates excellent and timely radiological procedural skills resulting in a comprehensive examination. Shows good clinical judgement following encounter	

Assessor comments – state areas of good practice and areas for development (mandatory)

Assessor comments – state recommendations for improving on unsatisfactory performances (mandatory)

Signature Trainee ______________________ Signature Assessor ______________________

APPENDIX C2

EXAMPLE OF A MINI-IPX ASSESSMENT FORM

Descriptors of competencies demonstrated during Mini-IPX.

Demonstrates knowledge of relevant anatomy	Does the registrar know the relevant anatomical landmarks?
Demonstrates understanding of the clinical context	Does the registrar interpret the images in the full context of supplied clinical information, and seek further information where this is required?
Demonstrates knowledge of indications	Can the registrar reason around the indication for the investigation?
Imaging Protocol	Does the registrar interpret the images using appropriate imaging protocols?
Observation of findings	Is there recognition of normality and abnormality within the case(s)?
Image interpretation	Does the registrar interpret the images using appropriate imaging protocols?
Appropriate reference to previous investigations	Where appropriate
Clarity of report	Does the report have a clear, concise, clinically appropriate and lucid appearance?
Appropriate Communication of Results	Is the registrar able to communicate accurate results in a clear and concise manner?
Judgment and insight	Does the registrar act on and have a sense of urgency when appropriate? For example, he/she communicates directly with referring clinician

Mini-Imaging Interpretation Exercise (Mini-IPX)

Name of Assessor ______________________

Name of Registrar ______________________

Student Number ______________________

Date of Assessment ______________________

Year of training 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Modality	Fluoroscopy	Plain Film	Ultrasound	CT
	MRI	IR	Nuclear Imaging	
System	Neuro/ENT	Thoracic	GI/HPB	Breast
	Genito-urinary	Musculoskeletal	Obstetric	Gynaecology

Case Description ______________________

____

	Below expectation for stage of training	Meets expectation for stage of training	Above expectation for stage of training	Unable to comment
Demonstrates knowledge of relevant anatomy				
Demonstrates understanding of the clinical context				
Demonstrates knowledge of indications				
Image protocol				
Observation of findings				
Image interpretation				
Appropriate reference to previous investigations				
Clarity of report				
Appropriate communication of results				
Judgement and insight				
Unable to comment – Please mark this if you have not observed the behaviour and feel unable to comment.				

Overall Competence		
Rating	Description	
Trainee requires additional support and supervision	Demonstrates little knowledge and lacking ability to evaluate issues resulting in only a minimal contribution to the radiology report and management plan	
Trainee requires direct supervision	Demonstrates some knowledge and limited evaluation of issues resulting in a limited report and management plan	
Trainee requires minimal/indirect supervision	Demonstrates satisfactory knowledge and logical evaluation of issues resulting in an acceptable report and management plan consistent with early higher training	
Trainee requires very little/no senior input and able to practise independently	Demonstrates detailed knowledge and good evaluation of issues resulting in a succinct report and clear management plan	

Assessor comments – state areas of good practice and areas for development (mandatory)

Assessor comments – state recommendations for improving on unsatisfactory performances (mandatory)

Signature Trainee ______________________ Signature Assessor ______________________

APPENDIX C3

EXAMPLE OF A TEACHING OBSERVATION ASSESSMENT FORM

Descriptors of competencies demonstrated during a Teaching Observation.

Introduction/gained group attention	A formal or informal introduction as appropriate. Ensures they have the full attention of the group before introducing the session.
Set out education objectives	Objectives should be shared with the group and should be SMART (specific, measurable, achievable, relevant and time based). They may be stated formally at the beginning of the session, or less formally as a general introduction. It is important that from the outset the learners are clear about what is expected of them, what it is hoped they will achieve by the end.
Delivery	Session has a clear beginning, middle and end. Topics and sub-topics are clearly linked together and placed into context. The session challenges but does not overwhelm the learners. There is clear development during the session moving from simpler material to more challenging concepts. Key points are emphasised at various stages of the session, to assist learning and allow learners to prioritise the main messages. Delivery is audible and learning points are understandable. Learning environment managed effectively, ground rules are clear, seating arranged appropriately.
Understanding of subject	Facilitator displays knowledge appropriate to the subject matter and subject being taught.
Resources	Teaching resources (slides / hand-outs etc.) are used to support the teaching and are designed to meet the needs of the group being taught.
Effective group participation	Appropriate interaction with the learners. Utilises different teaching strategies to maximise learning opportunities.
Teaching methods	A range of teaching and learning strategies is utilised, such as small group teaching, role-play and question and answer.
Feedback	Assessment methods are clear from the outset. Feedback is given where appropriate.
Timing	Session is delivered at an appropriate pace and facilitator’s voice used to good effect.
Conclusion	Clear summary of the main points of the session by facilitator or learners. Objectives revisited as appropriate.

Teaching Observation

Name of Assessor ______________________________

Name of Registrar ______________________________

Student Number ______________________________

Date of Assessment ______________________________

Year of training 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Setting ______________________________

Title ______________________________

Learner Group ______________________________

Comment on the registrar’s performance in terms of the following:

Introduction/ gained group attention

Set out education objectives

Delivery

Understanding of subject

Use of resources

Effective group participation

Teaching methods

Feedback

Timing

Conclusion

Assessor comments – state areas of good practice and areas for development (mandatory)

Assessor comments – state recommendations for improving on unsatisfactory performances (mandatory)

Signature Trainee

Signature Assessor

APPENDIX C4a

EXAMPLE OF A MULTISOURCE FEEDBACK FORM – GENERIC QUESTIONS

Generic questions about the registrar's daily performance – can be completed by all.

	I have **concerns** about the registrar's performance*	The registrar's performance is **adequate**	The registrar's performance is **good**	The registrar's performance is **outstanding**	Unable to comment
Communication skills					
Treats patients with respect					
Treats other staff with respect					
Teamwork					
Time management					
Punctuality					
Contactability					
Respects gender, age, racial and disability issues					
Observes confidentiality of patients and staff					

Covers work commitments					
Delegates appropriately					
Gives adequate notice of absences (holidays, courses etc.)					
Management skills (if appropriate)					
Overview of interventional skills (if applicable)					

Health:

	Yes	No	Don't know/unsure
Does the health of the doctor ever give rise to concern for patients or colleagues?			

Integrity and morality:

	Yes	No	Don't know/unsure
Do you have any concerns about the ethical, moral or financial integrity of the doctor?			

Any other comments:

* The selection of this option may generate further in depth appraisal/assessment if a trained facilitator judges that it is a valid observation. Specific comments would be helpful.

APPENDIX C4b

EXAMPLE OF A MULTISOURCE FEEDBACK FORM – SPECIALTY-SPECIFIC QUESTIONS

Specialty-specific questions about a registrar's daily performance – to be completed by medical peers.

Diagnostic work:

	I have **concerns** about the registrar's performance*	The registrar's performance is **adequate**	The registrar's performance is **good**	The registrar's performance is **outstanding**	Unable to comment
Quality of imaging reports					
Quality of imaging advice/knowledge					
Ability to analyse complex imaging problems (including clinical aspects)					
Works within limits of imaging expertise					
Keeps up to date with developments in imaging					

Interventional work (if applicable):

	I have **concerns** about the registrar's performance*	The registrar's performance is **adequate**	The registrar's performance is **good**	The registrar's performance is **outstanding**	Unable to comment
Quality of interventional work					
Incidence of complications (given case mix)					
Works within limits of interventional skills					
Keeps up to date with developments in interventional techniques					
Overview of interventional skills					

Any other comments:

* The selection of this option may generate further in depth appraisal/assessment if a trained facilitator judges that it is a valid observation. Specific comments would be helpful.

APPENDIX C4c

EXAMPLE OF A MULTISOURCE FEEDBACK FORM – RECORD OF COMPLETED MULTISOURCE FEEDBACK

Record of completed multisource feedback (MSF) and reflection on outcomes

Date MSF started:
Record of assessors asked to complete MSF: Please list the name, grade and team of each of your colleagues asked to be an assessor for your MSF. A minimum of ten responses from assessors is recommended. Please add more rows below if more than ten assessors were chosen. 1. 2. 3. 4. 5. 6. 7. 8. 9. 10.
Date MSF feedback received:
Main outcomes of MSF:
Reflection on outcomes:
Action points arising from outcomes of MSF; e.g., changes to practice: