An exploration of the meaning and development of critical thinking in diagnostic radiography

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Acknowledgements

"Learning without thinking is useless" - Confucius (551-479 BC)

"Listen to everyone but think for yourself" - My beloved father, Mr Jay Nandu (1939-2015)

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AP	Anteroposterior
APA	American Philosophical Association
CAQDAS	Computer-assisted qualitative data analysis software
CT	Computed tomography
CTC	Computed tomographic colonography
CXR	Chest X-ray examination
EVS	Electronic voting systems
GCSE	General Certificate of Secondary Education
HEA	Higher Education Authority
HEI	Higher Education Institution
HCPC	Health and Care Professions Council
IV1	First phase interview
IV2	Second phase interview
IV3	Third phase interview
MRI	Magnetic resonance imaging
NHS	National Health Service
NM	Nuclear medicine
NSS	National Student Survey
PA	Posteroanterior
PET	Positron emission tomography
QAA	Quality Assurance Agency
RDA	Radiology department assistant
RNI	Radionuclide imaging
SCoR	Society and College of Radiographers
SEEC	Southern England Consortium for Credit Accumulation and Transfer
SPECT	Single photon emission computed tomography
US	Ultrasound

Glossary

Ambulant (patient) – A patient who is able to walk as opposed to being transported in a wheelchair

Anaphylactic reaction – A serious allergic reaction leading to a range of symptoms

Appendicular (skeleton) – The portion of the body comprising of the upper limbs including pectoral girdles, and lower limbs including the pelvic girdle

Axial (skeleton) – The portion of the body comprising of the head and vertebral column

Band-six radiographer – A qualified radiographer that works at advanced practitioner level with involvement in team leader responsibilities and/or enhanced specialist imaging skills, for example, interventional or MRI

Bucky – This is a drawer-like mechanism that holds the image receptor in place during an X-ray examination

C-arm fluoroscopy unit – This is a mobile medical imaging unit that enables real-time X-ray imaging and is usually used in operating theatres for procedures, such as, internal manipulation and reduction of bony fractures.

Computed tomography – This is an imaging technique which uses X-radiation and computer processing to produce cross-sectional images of the body in various anatomical planes

Computed tomographic colonography – Computed tomography involving the administration of contrast medium and air insufflation to image the colon and surrounding body organs.

Computed tomography intravenous pyelograms – Computed tomography of the kidney, ureters and urinary bladder involving the injection of iodinated contrast

Fluoroscopic examination – An X-ray imaging examination that uses real-time imaging and the ingestion of contrast agents, e.g. barium sulphate solution, to produce images of the internal body organs, such as, the stomach and intestines.

Forensic imaging – The use of radiology, from plain X-ray examinations to virtual autopsies, in forensic practice

Image receptor – A device that is used to capture the X-radiation during an X-ray examination and converts that into a visible image

Interventional imaging – This refers to specialist medical procedures which involve radiological image guidance to precisely target therapy, e.g. angioplasty procedures

Ionising radiation – This occurs when particles, e.g. X-rays or Gamma rays, travel with enough energy to remove electrons from atoms causing the atoms to be become charged thereby resulting in ionisation in the medium through which it passes

Magnetic resonance imaging – This is a specialist imaging technique which uses strong magnetic fields to generate cross-sectional images of the body

Mammography – This is an imaging examination of the breast

Mediastinum – This is the membranous compartment of the thoracic cavity located between the lungs

Misdiagnosis – This is the failure to accurately diagnose a condition or failure to diagnose any problem at all

NHS Constitution – A document which sets out the principles and values of the NHS

Nuclear medicine – A specialist medical imaging modality involving the use of radioactive substances

Positron emission tomography (PET) – This is a type of Nuclear Medicine imaging that uses radiotracers to evaluate organ and tissue function

Protocol (imaging) – The agreed procedure, process or system to follow when conducting an imaging examination

Radiation dose – This is a measure of the amount of exposure to radiation

Radiographer – A healthcare professional who is trained in the safe use of medical ionising radiation and specialist radiographic techniques for imaging human anatomy to enable diagnosis and treatment of pathology

Radiographic technique – The method of positioning the patient that a radiographer uses to obtain a diagnostic image

Resuscitation room (Resus) – A key area in the hospital where patients presenting with immediately life-threatening illnesses or injuries are treated.

Single photon emission computed tomography (SPECT) – A Nuclear Medicine tomographic imaging technique that uses Gamma radiation to demonstrate blood flow to tissues and organs

Ultrasound – A medical imaging technique that uses high-frequency sound waves to view the inside of the body

X-ray request – This is a written request for an X-ray examination which is made by the referrer, usually a medical doctor, and contains important patient information that enables the radiographer to make justifiable decisions regarding the examination requested

Abstract

The development and application of critical thinking skills is a requirement and expectation of higher education and clinical radiographic practice. There is a multitude of generic definitions of critical thinking, however, little is understood about what critical thinking means or how it develops through a programme of study. Diagnostic radiography students struggle with demonstrating this skill to the desired expectation, and, in higher education it is assumed that both students and tutors understand what is required in relation to this expectation. Drawing on the work of seminal authors in the field, this study explores radiography students' and tutors' understanding and perceptions of the meaning and development of critical thinking.

The research framework sits firmly within the interpretive paradigm and was designed as a longitudinal study conducted over the three-year programme period. Semi-structured face-to-face interviews were employed as the means of gathering context-rich information from diagnostic radiography students (n=13) and tutors (n=5) who were purposively selected to participate in the study.

Participants' understanding of the meaning of critical thinking shared similarity with published definitions. Although the demonstration of critical thinking skills is explicitly assessed on the training programme, the teaching thereof was found to be implicit *rather than explicit* within the curriculum. Student responses revealed that although university played an important role in knowledge generation, it was clinical placement that played the major role in the development of critical thinking skills and dispositions. A definition framework of critical thinking in diagnostic radiography is presented in order to show-case the multi-faceted nature of critical thinking and recognises knowledge of the domain as its central feature. In addition, a progressive model of the development of critical thinking is presented. The findings demonstrated that students' development of critical thinking evolved through a recursive and shifting process rather than a linear trajectory.

A number of challenges have been discussed in relation to the development of critical thinking which have pedagogical implications for the training programme, for example, student motivation and engagement, learner autonomy, guidance provided to students and tutor support. In addition, the inclusion of a repertoire of focused critical thinking learning and teaching approaches from Level four to Level six will foster the development of this indispensable skill. Through exposure to well-articulated critical thinking tools, as diagnostic radiographers, we will be directed into new ways of thinking that will render expectations of practice such as decision-making more robustly defensible in the changing context of autonomous diagnostic radiography practice.

Chapter One

Introduction

1.1 Introduction to the chapter

The purpose of this chapter is to set the scene for the research study discussed within this dissertation. The study involved the exploration of radiography students' and tutors' understanding of the concept of critical thinking and their perceptions of how the skill develops through a programme of study. Background information and a rationale are provided detailing the need and importance of critical thinking in higher education (HE), and specifically in radiography education and practice. The structure of the dissertation is presented with brief descriptions of each chapter ending with a conclusion. Verbatim comments and statements by participants are presented in italics.

1.2 Background and rationale

Students in HE today are expected to both 'critically analyse' and 'critically evaluate' information for assessment at university. Analysis and evaluation skills are regarded as higher order thinking skills synonymous with critical thinking skills (Paul, 1993). Simple online searches on critical thinking yield information which indicates that developing critical thinking skills in students is a key pedagogical aim of higher education institutions (HEI) today. One example is seen in the following statement:

> Intellectual depth, breadth, and adaptability: The University encourages engagement in curricular, co-curricular and extracurricular activities that deepen and broaden knowledge and develop powers of analysis, application, synthesis, evaluation, and criticality. Our graduates will be able to consider multiple perspectives as they apply intellectual rigour and innovative thinking to the practical and theoretical challenges they face (University of Hertfordshire, 2016).

In addition, the UK Quality Code for Higher Education (QAA, 2012) states that it is the responsibility of the HEI to produce graduates who possess the skills required to enable the development into autonomous practitioners. It sets out the following national expectation about learning and teaching which HE providers are required to meet, namely:

> Higher education providers, working with their staff, students and other stakeholders, articulate, and systematically review and enhance the provision of learning opportunities and teaching practices, so that every student is enabled to develop as an independent learner, study their chosen subject (s)

in depth and enhance their capacity for analytical, critical and creative thinking (QAA, 2012: 6).

Developing critical thinking skills in learners is, therefore, a well-defined expectation and outcome of higher education (Paul, 2005; Sharp et al., 2013). However, Arum and Roksa (2011, in Sharp et al., 2013: 3), found that many college graduates graduate "without knowing how to filter fact from opinion." In radiography education, a lot of emphasis is placed on reading peer-reviewed journal articles 'critically' to use the information in an informed manner to influence practice. This would then enable the participation in evidence-based practice upon qualification. Clinical practice publications are meant to demonstrate the efficacy, or lack thereof, of common elements of practice by drawing upon the latest research findings. The process of critical appraisal in scrutinising the validity and reliability of results of these research studies are then crucial in helping practitioners decide how to adapt their practice in relation to the findings (Gupta & Upshur, 2012). The ability to critically appraise information is dependent on one's ability to think critically (Gupta & Upshur, 2012). However, "despite widespread attention" to developing critical thinking, today's education structure "does not develop the reasoning skills needed to succeed in the 21st century" (Sharp et al., 2013: 3).

"The centrality of critical thinking skills is clearly reflected in competency frameworks across health professions" (Huang et al., 2014: 95). As mentioned above, radiography students in HE are required to develop the skills of thinking critically so that they can make meaning from information and apply it to both their university assignments and in their clinical practice. By so doing they will be able to improve their thinking abilities which will improve their levels of competence in critical analysis, defined later in the chapter. Evaluating student performance following assessment is the first indication we have as tutors of a student's ability in being able to critically analyse information. Little is understood though on how this skill develops through a programme of study (Flores et al., 2012). Although studies have been conducted on the assessment and measurement of critical thinking skills, and pedagogic practices to foster the development of this skill (see Literature Review) no study has explored the meaning of critical thinking with a specific focus to diagnostic radiography nor its perceived development in radiography students (Castle, 2009), making it, therefore, an important area to be explored within the profession.

1.3 The importance of critical thinking in diagnostic radiography education and practice

The purpose of this section is to contextualise the requirement and importance of critical thinking skills within diagnostic radiography. The practice of diagnostic radiography and the

role of a radiographer are detailed together with a snapshot of the expectations and regulations that govern their practice. The scope of autonomous practice is discussed together with the ethical and moral expectations of a radiographer and closes with a summary.

1.3.1 The practice of diagnostic radiography

MacIntyre explains the meaning of 'practice' as:

> any coherent and complex form of socially established cooperative human activity through which goods internal to that form of activity are realised in the course of trying to achieve those standards of excellence which are appropriate to, and partially definitive of that form of activity, with the result that human powers to achieve excellence, and human conceptions to the ends and goods involved, are systematically extended (MacIntyre,1985: 187).

In order to deconstruct and understand this definition, I consulted the work of Fitzmaurice (2010). Fitzmaurice explained that practice involves within it certain standards of excellence; when one participates in such an area they accept the standards and perform in a way which allows them to judge their performance against those standards. This means that the role they took could only be performed by entering into that specific field of work and, could only be identified and recognised by virtue of participating in that field of work. The quality inherent to that field ('goods') can only really be specified in relation to that field and can only be identified and recognised by participation in that field. In addition, Paul posits that "learning to think in any discipline is learning to discipline one's thought by standards inseparable from values presupposed in each discipline" (Paul, 1990: 4).

With MacIntyre's definition of practice in mind, and taking into account Paul's clarification, the practice of radiography is concerned with but not limited to diagnostic and interventional imaging procedures, health screening programmes and research activity. Professional and regulatory bodies produce guidance for best practice which marks the standards of excellence, which Fitzmaurice (2010) refers to above, by which radiographers are expected to practice. Those standards are considered as best practice. The Society and College of Radiographers (SCoR) and the Health and Care Professions Council (HCPC) are, respectively, the professional and regulatory bodies for diagnostic radiography. The scope of radiographic practice has changed significantly during the last two to three decades. Traditionally radiographers practiced under the guidance of a radiologist (medical doctor) who had full responsibility for undertaking radiological examinations and procedures. However, the scope of radiographic practice today involves responsibility for an increasing number of radiological (imaging) examinations and procedures that were previously undertaken by the radiologist. In addition, the need for evidence-based practice, patient-centered care and addressing patients'

satisfaction with their care (Chan, 2013), as well as working conditions, especially in light of the new shift system and seven days working in radiography, the scope of practice has become more demanding and complex.

Radiographers are responsible for providing fast, safe and accurate diagnostic imaging examinations in a range of clinical areas usually within a hospital setting, such as accident and emergency (A&E), general examinations, ward and operating theatre radiography, computed tomography (CT), magnetic resonance imaging (MRI), ultrasound, nuclear medicine, interventional and specialised fluoroscopic imaging. They are trained to work with a range of patients and service users whereby examinations conducted span the life-cycle of the population from foetal imaging to elderly patients. Radiography practice entails the extremes of health from screening tests, such as mammography for breast evaluation, to examining those with severe trauma or terminal illnesses. Radiographic practice also involves post-mortem examinations and forensic imaging (QAA, 2001).

In their daily role, radiographers have to pay careful attention to justifying the need for an X-ray examination with a particular focus on patient history, clinical information required and the feasibility of the examination in relation to a patient's condition at the time. Radiographers also act as an advocate for their patients. Key aspects of their role involve teamwork, managing complex interpersonal dynamics and autonomous practice (QAA, 2001). The unique and somewhat unusual aspect of radiographers' practice is that they have limited, often short amounts of time with a patient. In that brief encounter, they are required to examine a patient whilst using their effective interpersonal and highly developed communication skills to establish rapport and provide the psychosocial care that eases the anxiety in the often acutely ill patient. "Rapid decision-making and effective clinical reasoning" (QAA, 2001: 8) is therefore a requirement to ensure the most appropriate imaging examination, with respect to a patient's condition, has been carried out.

1.3.2. Scope of autonomous practice

One of the key attributes of an autonomous practitioner is to be able to make sound clinical decisions using evidence to justify decisions made. Autonomy means, "…the right or condition of self-government" (Oxford Dictionaries, 2018a). Synonyms of autonomy include independence, self-determination, and freedom (Oxford Dictionaries, 2018a). However, with autonomy comes responsibility and accountability for decisions made in one's practice (Dimond, 2002; SCoR, 2013a). From the media it is evident that the public is demanding greater accountability from government agencies and professional services including the

National Health Service (NHS) and, given the current climate of change, debates often feature the key word, 'accountability' (Dimond, 2002; Francis, 2013). Accountability is defined as "the fact or condition of being accountable" and has been linked with responsibility (Oxford Dictionaries, 2018b). Greater accountability is required when mistakes are made. Broadly speaking mistakes, in relation to radiography, occur when choices result in a negative or less desirable outcome for a patient (Crigger, 2004). A mistake means "an error in action, calculation, opinion or judgment caused by poor reasoning, carelessness, insufficient knowledge or misunderstanding" (Dictionary.com, 2018a). Errors in diagnostic radiography typically involve incorrect positioning of the patient, miscalculating the amount of X-radiation required for an imaging examination, or misinterpreting an X-ray image. Low application of critical thinking skills has been linked to mistakes in diagnosis and image interpretation (Agwu et al., 2007).

In his report following the public inquiry into the failings of the Mid Staffordshire NHS Foundation Trust, Sir Robert Francis concluded that "the evidence demonstrated that the reasoning adopted (by medical professionals) was flawed" (Francis, 2013: 53). This led to multiple failings, on the part of the medical professions involved, in "their duty to protect patients" (Francis, 2013: 53). Although the failings exposed within the report were not directly related to diagnostic imaging practice, the SCoR published a response which highlighted the need for vigilance in our daily practice so errors could be minimised and the concerted effort by all players within the profession could be strengthened (SCoR, 2013b). Radiographers need to exercise vigilance and care in how they exercise their decision-making skills (Agwu et al., 2007). From my experience of being the programme leader and tutor, one of the key areas which needs to be strengthened within diagnostic radiography practice is decision-making, which due to our professional expectations and responsibilities, is a vital skill to develop.

In a study conducted by Paterson and Price (1996), it was found that the skills required for professional practice and role development such as evaluation, problem-solving and decision-making were not fully exercised by radiographers. Considering that role development was beginning to gain ground during the nineties this statement was not a surprise. However, twenty years on, with the scope of practice having evolved through a period of considerable growth, it remains an area that is under-developed. It is imperative that radiographers utilise their skills of evaluation, problem-solving and decision-making to minimise errors in practice. Thompson and Dowding (2002) found that problem solving, and judgment is linked to critical thinking, which Simpson and Courtney (2002) affirmed is linked to making clinically sound decisions. The ability of a radiographer to make decisions based on reasons using reliable thinking processes forms the fundamental aspect of autonomous practice. On a basic level of

autonomous decision-making, this would typically involve a radiographer considering the criteria of an imaging examination request. Such a radiographer would then decide on the viability of the examination following an appraisal of the benefits of the examination in relation to the risks of the examination with due regard for patient safety. Following this, the radiographer would make the decision to go ahead with the examination requested or suggest an alternate examination. This process requires the application of critical thinking skills.

In practice today, there are protocols for a number of examinations which a radiographer can follow in a routine manner. In so doing radiographers can practice safely in routine situations without the use of critical thinking skills. Radiographers can also bypass their decision-making process by asking another radiographer for advice. Typically, such practice would involve a radiographer asking a colleague (another radiographer) for direction on what should be done, and then diligently following the given set of instructions. This is similar to the traditional working of a radiographer. In so doing radiographers will still be safe in their practice, provided the advice given ensures safe practice, but as a result of asking another radiographer to make the decision, they are not utilising their critical thinking abilities or exercising their autonomy. Hence, they are not practicing as autonomous radiographers. This will pose challenges to them during situations of lone working, e.g. during night shift or on-call duties where there may not be another radiographer on duty at the time. As a consequence, they will not develop their critical thinking skills to the extent required for autonomous practice. According to Sim and Radloff (2009) the largely protocol-driven practice of radiographers is the main reason for radiographers not developing their thinking abilities. Protocols refer to predetermined instructions that radiographers have to follow during imaging examinations. These can be modified according to the individual needs of the patient, and this is where critical thinking skills are required but problems occur because protocols are not consistently or appropriately modified. Students, therefore, need to learn to practice beyond the use of protocols and routine ways of working.

1.3.3. The importance of critical thinking skills development in radiography

As the scope of radiography practice continues to expand to take on examinations traditionally undertaken by radiologists, it is vital to their learning and practice that student radiographers develop and use critical thinking skills (Edwards, 2006). Such skills are important to be able to satisfy the requirements for reflective practice and the need to use evidence to inform practice (Castle, 2006). The reason for this is the expanding scope of diagnostic pathways to meet increased demands on imaging services. Existing services are already under a lot of pressure. Additional pressure to provide these services within shorter time frames is a

challenge due to the respective increasing complexity of imaging investigations and volume of radiology examinations being carried out (SCoR, 2013c).

The SCoR's education and career framework sets out the expectations for autonomous practitioners. The document highlights the demonstration of accountability, recognition, and responsiveness to strengths and limitations in their own and others knowledge, skills and attributes by stating that "all radiographers at the point of registration are competent to practise autonomously in their discipline" (SCoR, 2013d: 16). Graduate radiographers, therefore, are considered as autonomous practitioners. In addition, the SCoR's research strategy for the profession details the following objective to achieve one of their strategic aims, "to develop a radiography workforce that engages critically with research to ensure that care provided to service users is based on the best available evidence" (SCoR, 2016: 6). They advise further that all "undergraduate and postgraduate training programmes must contain components that develop critical research appraisal skills" (SCoR, 2016: 6). Furthermore, the QAA Benchmark Statements for Radiography (2001) give detailed guidance on the expectations of a radiographer with regard to professional autonomy and accountability which need to be included in the training programme. The skills for training programmes set out by the QAA (2001) consequently includes, among the vast range of radiography specific skills, problem-solving; clinical reasoning; sound professional judgment; ability to evaluate, analyse, reflect, think logically, systematically and conceptually, synthesise knowledge and understanding. I include a data extract from a tutor participant who explained:

> *…it is very important for students, and for us, I guess because the profession has changed so much from when there wasn't so much thinking involved or accountability. Now we've got an increasingly intelligent public, they're questioning, they know their rights, and they wouldn't think twice about questioning us. So it is important for us, then, to be thinking critically, or think, about what we're doing. And that filters back down to the best thing for the patient at the end of the day.* (Sophia)

If radiographers are to deal effectively with complex change as seen in dynamics within the profession today, then their ability to think and reason needs to be highly developed (Simpson & Courtney, 2002; Edwards, 2006). As radiography is a specific subject area, for critical thinking to take place a radiographer must have knowledge and comprehension of specific subject area and must possess the ability to analyse, synthesise and evaluate the information by using reason to make a judgment that will result in a decision about what action needs to be taken as a result (Edwards, 2006). Only then will the information be transformed into useable knowledge. In other words, the skills required for autonomous practice are higher order thinking skills (Paul, 1993) synonymous with the skills of analysis, evaluation, and synthesis (Bloom, 1956). Radiographers' practice is concerned with purposeful, goal-oriented

thinking whereby they are thinking about how to go about doing something and 'to make a decision that will yield the best outcome for patients. Decision-making is a topical word in healthcare research today (Jeong, 2015). Students graduating from a radiography training programme must already be in possession of those skills required for decision-making. In fact, decision-making on clinical placement is already a criterion for students to achieve to pass their competency assessments. What needs to be investigated is how we, as tutors, actually prepare students to grow and develop their decision-making skills.

Furthermore, radiographers are encouraged to embrace innovations and changes that will bring about quality service improvements. Service improvements initiatives are expected to be implemented and monitored against the inevitable backdrop of continuous staff shortages and cost containment within radiology departments coupled with increasingly high expectations of patient care. Due to increased public accountability and patients' high expectation of care, improvement in the quality and scale of services we offer as radiographers will be an ongoing process. Thus, it can be inferred that a relationship exists between critical thinking and effective quality improvement initiatives (Simpson & Courtney, 2002). Radiographers are supporting this development by being trained to perform image interpretation or preliminary clinical evaluation of diagnostic medical images which involves the detailed examination and interpretation of the image and writing of a report based on their findings or interpretation. Image evaluation involves evaluating the image at the time it is processed immediately following the examination. Competency in the preliminary clinical evaluation and clinical reporting is an expectation of an autonomous practitioner. Radiography training programmes, such as the researchers' training programme, have included the principles of image assessment and reporting at the undergraduate level to meet this expectation (SCoR, 2013e).

There are a number of criteria radiographers need to take into account before they are able to provide a clinical report. For example, they need to consider a patient's clinical history and indications (signs and symptoms), patient presentation and appearance of the image. Following the interpretation of the image of a patient, a radiographer needs to decide whether to apply the routine process of referral or whether, due to the nature of the abnormality or pathology seen on the image, to initiate an immediate review. Reporting radiographers also refer patients for further examinations if they consider it necessary. The process of image reporting, referral or the decision to expedite a review requires the use of critical thinking skills. 'Referral' here is used in the context of a patient being referred back to their doctor or the health/medical professional who requested the imaging examination. 'Review' in this context refers to the evaluation and interpretation of the radiographic image.

In addition to the skills required for report writing, the role expansion of a radiographer also takes into account the conduct of more specialist imaging examinations that were previously undertaken by the radiologist, e.g. barium studies, computed tomography (CT) colonography and CT intravenous pyelograms among others. Apart from the risk of being exposed to harmful radiation during the procedures, those examinations are considered to be minimally invasive, but can carry additional risks of harm or significant side effects to a patient. Examples of these may be anaphylactic reactions from the use of contrast agents. Contrast agents in medical imaging are chemical compositions containing iodine or barium sulphate solutions, which increase the visibility of internal body structures in imaging examinations. Furthermore, in the case of patients undergoing CT colonography screening, the risk of perforation and psychological harm in the incidence of false positive and false negative results can arise (Ramlaul & Gregory, 2016). A false positive result is where a person without a disease is diagnosed as having a disease. Conversely, a false negative result is the failure to diagnose a person with a disease as having a disease. True positive and true negative results correctly identify a person as respectively having the disease or not having the disease. False positives and false negative results constitute diagnostic errors arising from decision-making among other reasons, and as such have significant psychological ramifications for patients and cost implications for the NHS. These also have considerable implications for the safe and professional practice expected of autonomous practitioners.

By developing their scope of practice, radiographers are helping to meet the needs of both patients (SCoR, 2013b) and the NHS. It is, therefore, necessary that radiographers undertaking these extended roles have further training in clinical practice to specialise in those examinations in diagnostic radiography and imaging. However, the skills for learning to be able to progress to autonomous practitioner undertaking an extended role must be cultivated at the undergraduate level. In a study conducted by Castle (2009), students in their second year of training were unable to adequately use judgment in their appraisal of evidence. This should have had a pragmatic application in deciding what to believe or do and how to apply that decision. This is a matter of concern because best practice requires the assessment of strengths and weaknesses or arguments and supporting evidence. In the same study, students in their third year of training were unable to adequately demonstrate the skill of inference during reflection on the methodological approaches used in their research projects. The concern here is one of clarity whereby students were unsure about how to make meaning from their reflective thoughts. Making meaning from one's reflective thoughts requires one to think about their thought process in a reflective way, in order to be able to analyse their actions and decide what to do differently next time and why. This, therefore, has implications for the

development of critical thinking skills in student radiographers as well as the wider implications of service improvements through implementation of evidence-based practice, in addition to those already mentioned. One tutor participant sums up the reality in relation to the implications for practice below:

> *Firstly, it is a safety reason, we are using radiation that could be detrimental to a patient's health especially with specialist imaging of CT scanning, and barium studies etc., so making the wrong decision means that we may unnecessarily irradiate the patient. We make decisions on what the appropriate area is and what doses of radiation we give, so if we don't make the right decisions, then we are giving patients unnecessary radiation. Or alternatively we may make a decision not to irradiate and if we have made the decision wrongly, then the patient might not have the treatment that they might need based on the fact that the pathology they had will not have been identified. Although we don't request these examinations, we act as gate-keepers. This is to give the patient an appropriate experience.* (Mia)

1.3.4. Moral obligations of a radiographer

Radiographers are importantly required to practice within ethical and legal boundaries defined by their professional and regulatory bodies. The theory of ethics has its historical origins in the discipline of philosophy and came about to address moral issues in society (Smith & Jones-Devitt, 2007). Ethics, therefore, is understood to be grounded in a social system which is governed by a set of codes or expectations in behaviour. 'Ethics' simply means to decide between right and wrong or good or bad, in a given situation (Schwartz et al., 2002). How we decide to behave is dependent on our "own moral sense, values and beliefs, which are influenced by our cultural and family background, religious beliefs, political views and prejudices" (Ramlaul & Gregory, 2013: 258). 'Morals' is defined as having a "code of behaviour that is considered right or acceptable in society" (Dictionary.com, 2018b). Radiographers are required to "cross and re-cross the bridge" of rational thought in their "ethical decision-making in practice" (Edwards & Delany, 2008: 288). In so doing they will be able to demonstrate moral sensitivity, by being "open to differences" (Edwards & Delany, 2008: 288) that exist between people who make up the diverse patient population presenting to the NHS today. However, an emotional response is perceived as an important motivator of critical thinking (Riggs & Hellyer-Riggs, 2013).

Moral reasoning is seen as the application of ethical codes in a rational and logical manner, where all sides of the problem are considered in an open-minded and non-judgmental way (Smith & Jones-Devitt, 2007). 'Open-mindedness' and being 'non-judgmental' are considered as dispositions associated with critical thinking (Ennis, 1989; Facione, 1990; Halpern, 1997),

and are discussed in Chapter Two. The challenge for critical thinking application here is whether and how a radiographer is going to choose to use moral reasoning in the decision-making process. Radiographers have the responsibility of making a decision that is 'right' for a patient; however, their moral outlook may not "blend harmoniously with their practice or performance of duties" (Ramlaul & Gregory, 2013: 258). Radiographers being human are social beings and as such can be influenced by social cultures, biases and stereotyping which may affect their judgment. In order for radiographers to be objective in their decision-making, they must have the ability to recognise an ethical problem and know what appropriate action to take to justify a moral outcome (Smith & Jones-Devitt, 2007; Ramlaul & Gregory, 2013). I agree with Dewey who stated:

> the trained mind is the one that best grasps the degree of observation, forming of ideas, reasoning, and experimental testing required in any special case, and that profits the most, in future thinking, by mistakes made in the past (Dewey, 1933: 78).

It is hoped that by raising awareness of the expectation to develop critical thinking skills, as radiographers we can learn from mistakes made in the past and work together to take our commitment and practice to new levels. While scientific evidence grounded in facts is by its very nature objective, ethical dilemmas by their very nature evoke emotion, the extent of which varies and is dependent on how people view the problem.

1.3.5. Summary

In this section, the requirement and importance of the need for critical thinking in radiography are presented. The role of a radiographer has expanded to undertake procedures previously conducted by a radiologist. Being an autonomous practitioner is an important role that has consequences if poor decisions are made. Consequences are related to diagnostic errors which affect patient outcomes and care and are a huge cost to the NHS. Such consequences may also call into question our commitment and trustworthiness as practitioners and affect the public's opinion of the services we provide. Radiographers are expected to practice in accordance with the ethical and moral standards as set out by their professional and regulatory bodies.

1.4. The research problem and its significance

Critical thinking is a term used by academics in HE frequently and confidently (Moon, 2008). They do so under the assumption that students are fully aware of what the terms mean. Borglin and Fagerstrom (2012) comment that students in HE experience difficulties in being proficient in critical thinking and appraisal. Their findings reflect the situation of students on the

researcher's radiography programme. Currently, student assessment feedback consistently highlights the need for increased critical thought. For example, feedback to students frequently features the words, 'lack of critical analysis' or 'lack of critical thought/comment.' Such feedback is necessary to inform students' reasoning and enhance their written abilities. Radiography students rarely experience difficulties in learning the skills of clinical radiographic practice. However, the academic skills acquisition process has been seen to be challenging to most. This is evidenced in student performance as presented at examination boards yielding a greater percentage of achievement, i.e. 75% of students achieve within the 40-59% grade bands, as compared to 20% in the 60-100% grade bands. For completeness, the remaining 5% of the cohort represents the number of students who do not pass that year of study. This indicates the progression of a typical cohort. However, progression in cohorts varies year to year. Students achieving grades between 60-100% demonstrate competencies in higher-order skills development: critical thinking. Education by itself does not necessarily lead to better thinkers (Flores et al., 2012) yet it has been assumed that students graduating from basic education programmes will have acquired critical thinking skills; this is not a reliable assumption (Castle, 2006). The implication in terms of learning for those students who do not achieve these higher order skills is that their ability to participate in evidence-based practice may be hampered (Broadbear & Keyser, 2000). Therefore, understanding the meaning of what exactly is required when asked to think critically and perceptions of how this skill develops is central to this study.

The history of critical thinking is perceived to seek ways of understanding the mind and training the intellect, so errors are minimised or eradicated altogether (Paul, 1993). This is particularly important for the caring professions such as radiography, where making decisions based on judgment affects the lives of those we are caring for. Critical thinking itself is not an explicit part of the radiography academic curriculum on the researcher's programme. However, being 'critical' is a trait that is desirable in healthcare practitioners. What is explicit though is the overt assessment of critical thinking ability by demonstration of critical analysis in coursework assessment, and students' ability to justify X-ray examinations. Assessment marking criteria have defined expectations for critical analysis and evaluation, with those criteria given a higher weighting from Level four to Level six in accordance with the South East England Consortium for Credit Accumulation and Transfer popularly known as the SEEC level descriptors (SEEC, 2016). Analysis and evaluation are higher order thinking skills (Bloom, 1956), see Section 2.6, p. 35. The fact that more emphasis and weighting is given to these higher-order thinking skills from Level four to Level six gives the impression that critical skills development appears to be a linear process. Bearing in mind that although critical thinking skills itself are not explicitly taught, most students are achieving the criteria to pass at those levels. This implies that

students are developing those skills through a process of 'osmosis' as tutors commonly say. In other words, acquisition of such skills is being gained as a secondary effect from learning tasks that required critical thinking, rather than by being explicitly taught.

We need to consider that if students are indicating skills development by merely passing the assessment criteria then perhaps facilitation of learning exercises and assessment conducted through alignment of those exercises with the assessment criteria are already taking place. Nonetheless, radiography education providers have to ensure that the curriculum provides opportunities for students to develop these skills and that those skills are assessed throughout the programme of study so that graduates who enter the profession are already in possession of those skills necessary to undertake autonomous professional practice. However, whether the curriculum does in fact support the development of critical thinking in radiography remains to be investigated. In addition, whether the development of critical thinking skills is, in fact, a linear process will be revealed by the findings.

1.5. Thesis argument

In order for academics to fully advise students of the nature of critical thinking required for university study, academics themselves need to understand what is meant by the term 'critical thinking' (Broadbear & Keyser, 2000). Castle (2009) points out that, although students are required to develop and demonstrate critical thinking skills during their studies, critical thinking itself is inadequately defined. To begin with, he says, students often are unsure of the meaning of critical thinking and do not usually attempt to challenge the information presented to them by academics in their field. Castle (2009) elaborates that students do not usually ask the meaning of the concept as they feel they are expected to already know what critical thinking means. The dilemma herein is if students do not ask and academics do not teach how to acquire such skill then how do we, as academics, expect the skill to develop? Furthermore, if academics do not understand what critical thinking means and how to apply it then how are they going to instruct students regarding what the skill is and how they would develop the skill? The responses to these questions will determine any pedagogical implications, if applicable, for teaching and learning on the radiography programme.

1.6. Purpose of study

The purpose of this study is to explore the respective understanding of critical thinking by radiography students' and radiography tutors' and how each of them perceives critical thinking

skills to develop through the duration of the training programme. The study cohort began their training in September 2013 and completed as graduate practitioners in July 2016. The student participants were interviewed three times within this period: at the beginning of their first, second and third year of study, as indicated in Table 1, p. 65. My premise is aligned with that of Fesler-Birch (2005) who states that there is no published work that tells us how this skill develops over time. In addition to the study topic, the longitudinal design of the study is a gap in the field of critical thinking research. The research exploration of how critical thinking develops is therefore evaluated over a period of time. The study also aims to explore the pedagogical implications for teaching, learning, and assessment on the training programme. By exploring student and tutor understanding of critical thinking and comparing this to relevant literature a framework definition is presented. By exploring how both students and tutors perceive the development of critical thinking skills through the programme of study, a model for the development of critical thinking skills relevant to radiography education and training is presented.

1.7. The research questions

Following the above-mentioned purpose of the study, there are three research questions,

1. What is radiography students' and tutors' respective understanding of what is meant by the term critical thinking?
2. How do radiography students and tutors perceive the development of this skill through a programme of study?
3. What are the pedagogical implications for teaching and learning on the radiography programme?

1.8. Originality and contribution to practice

With specific regard to radiography education, the literature review in the next chapter identifies gaps within this area. There is no extant published qualitative work that focuses on understanding of the respective critical thinking of radiography students and tutors and how this skill develops in radiography education and training. There are, however, studies conducted in radiography that focus on evaluating teaching strategies used to develop critical thinking rather than exploring its development through a training programme. The study was therefore developed to explore the research questions and to meet the aim of the study. It was anticipated the study will bridge the gap that currently exists within the published domain. In this manner, it is considered as primary work in the field of exploring critical thinking in

radiography education; it is envisaged that the study will make a new contribution to education and practice. I am standing on the shoulders of giants in the field of critical thinking yet the gap, among the vast amount of literature research, is that there has been no qualitative exploration of critical thinking meaning and development conducted in diagnostic radiography. This qualitative study was conducted over three years and should bridge this gap and lay the foundation for further work in this field.

1.9. Brief description of the method

Approval was granted by the ethics committee with delegated authority from the university at which the study was conducted. The study is of longitudinal design and involved exploratory face-to-face semi-structured interviews using an interpretive method of inquiry. When the study commenced there were 14 radiography student participants, but one participant left the course at the end of the first year, therefore n=13. There were five (n=5) radiography tutors. Student interviews took place at the beginning of each year over the three-year training programme period. The tutor participants attended one face-to-face interview. All interviews were voice recorded and transcribed. Transcriptions were sent back to all participants for confirmation of accuracy. All participants verified the transcriptions as a dependable record of their respective interviews. Transcriptions were then coded and categorised using a basic level of NVivo computer-aided qualitative data analysis software. Analysis of findings was undertaken using thematic analysis.

1.10. Structure of the dissertation

There are nine chapters in this dissertation.

Chapter Two provides a critical review of the relevant literature focusing on an analysis of the meaning of critical thinking published by seminal experts from the fields of philosophy, psychology, and education. A conceptual framework was devised from the review process. The review further focuses on the development of critical thinking seen through Bloom's taxonomy (1956), and the skills and dispositions of critical thinking.

Chapter Three provides the theoretical underpinning of the study and justifies the chosen research methodology and method employed in the study. The research process is detailed followed by a description of the process followed in the analysis and interpretation of data. In addition, the chapter discusses criteria for assessing trustworthiness in qualitative data collection, analysis, and interpretation.

Chapter Four provides an analysis of the findings in relation to the first main theme, 'participants' understanding of the *meaning* of critical thinking.'

Chapter Five provides an analysis of the findings in relation to the second main theme, 'participants' perception of how critical thinking *develops* through a programme of study.'

Chapter Six provides a critical discussion of the themes in light of theory and presents a visual framework definition of critical thinking. In addition, a progressive model of critical thinking development in diagnostic radiography is presented which builds on the framework definition.

Chapter Seven addresses the challenges experienced by participants in relation to the development of critical thinking skills and discusses the resultant pedagogical implications for radiography education and training.

Chapter Eight provides an insight into my reflexive position as a tutor, programme leader, and researcher. The intricacies of the insider-outsider perspective and related power dimensions add further interest, conflicts and dilemmas to these roles. I discuss how I managed the various stages of the study ensuring its trustworthiness through methodical and rigorous conduct.

Chapter Nine summarises the aim, objectives, and findings of the study and offers recommendations and areas for further work based on the findings.

1.11. Conclusion

In this chapter, the rationale and background of the study are presented. The requirements for critical thinking in diagnostic radiography are provided with an outline of the scope of practice of the profession. Apart from the skills development requirement for autonomous practice, as set out by the professional body for radiography, the Society and College of Radiographers, development of critical thinking skills is a key pedagogical requirement for HE. The lack of critical thinking abilities in a radiographer's daily role has implications for their practice. Critical thinking needs to be adequately defined for use in radiography education and training. As tutors, it is imperative that we understand the complexities and nuances associated with understanding what the term means, and in having a clear framework which can be implemented to enhance the development of critical thinking skills through a programme of study. By establishing perceived current understanding, we will be able not only to properly instruct and guide our students, but also build on that knowledge in a developmental way to suggest meaningful changes to our teaching, learning and assessment processes for positive pedagogical impact.

Having presented a background and rationale for the study topic, the next chapter provides a critical review of related literature.

Chapter Two

Literature review

2.1. Introduction

The purpose of this chapter is to contextualise the study topic within published work in the field of critical thinking. Literature relevant to the specific focus of the definition and development of critical thinking is reviewed. It is not my intention to review all work within critical thinking or its component skills, but rather to focus on those publications that sit well within the framework of my study. The chapter unfolds with a brief description of the literature search strategy employed to search and retrieve information on the topic. A brief mention of the similarities of issues with critical thinking in nursing follows thereafter. Following on from this is a discussion of the definitions of critical thinking from prominent authors in the field of critical thinking. An appraisal of the key skills and dispositions of the critical thinker is provided. Bloom's taxonomy (1956) in relation to the development of critical thinking is analysed and the role of pedagogy in developing critical thinking skills is outlined. The chapter closes with a summary.

2.2. Literature search strategy

The purpose of this section is to provide an overview of the strategy used in searching and retrieving information used in this study. Literature searches were conducted using a number of hard copy textbooks and online databases. Rich Site Summary (commonly known as RSS feeds) and alerts were set up to receive weekly updates on recent publications. Literature searches were conducted on the topic of radiography students' and tutors' respective understanding of what is meant by critical thinking in higher education. Search terms included, but were not limited to: critical thinking; radiography; students; lecturers; tutors; decision making; reasoning; thinking; development of critical thinking in higher education; clinical reasoning; autonomous practice, etc. These were used in Google Scholar, Web of Science, Science Direct, Higher Education Empirical Research (HEER), Z Electronic Table of Contents (ZETOC), and Education Resources Information Center (ERIC) database searches. Boolean operators, AND and OR, were used to combine key search terms and phrases and further streamline the searches. No date or language-specific filters were applied to the searches in order to optimise the breadth of search yields.

The searches yielded thousands of hits on the topic of critical thinking. Whilst there was an abundance of literature relating to the meaning of critical thinking and tests to measure this

skill, there was a paucity related to how critical thinking develops. The focus of my study lies in exploring its meaning and perceptions of its development. Therefore, literature relating to its measurement, although alluded to, was not considered for this study. No published qualitative interpretive work with regard to radiography students' and tutors' respective understanding of what is meant by critical thinking in radiography higher education or its perception of development was found. In addition, a search on e-theses online service (EThOS) from the British Library evidenced that there was no published doctoral thesis in this area of research (see APPENDIX 1). As a result, the topic is assumed to fill a gap within the literature and is thus a valid reason for its examination. This is the unique aspect of the study where a new contribution to education and its practice is argued to have been made.

Due to the dearth of literature on critical thinking in radiography, publications in other areas of healthcare namely, medicine and nursing were considered for this study. The literature search revealed that there are more publications on critical thinking in nursing as compared with that of medicine. This was noticed by Cody (2002), who states that in 2002 publications on critical thinking were mainly from the nursing and educational domain. In addition, Cody (2002) rightfully asserts that most publications have turned away from the philosophy of the education to the range of learning and teaching activities that can develop these skills. Literature searches for this study conducted more than a decade later revealed the same finding. Furthermore, a distinct lack of publications from the allied health professions is evident. Sharp et al. (2013) state that research from the allied health professions appears overlooked, with respect to encouraging publications, within the healthcare industry. This adds greater strength to the justification of this study as a much needed area of exploration within radiography which sits within the domain of the allied health professions. Although the qualitative exploration of the meaning of critical thinking was not found, a number of popular studies using a quantitative and/or a mixed methods approach were found. These involved categorising of definitions of critical thinking (Simpson & Courtney, 2002; Banning, 2006; Riddel, 2007), and tutor dispositions towards critical thinking (Gosnell, 2010; Jeong, 2015). However, the largest body of studies involved measuring or assessing critical thinking skills development of students using critical thinking assessment tests.

2.2.1. Summary

In this section, the expectation for critical thinking skills development in higher education is outlined and the literature search strategy employed in the study is described. The next section provides a rationale for the use of nursing literature within this study.

2.3. Rationale for the use of nursing literature in this study

The purpose of this section is to draw similarities in relation to the requirement for critical thinking development in both diagnostic radiography and nursing practice. Considering that the respective training programmes of nursing and radiography consist of similar pathways and expectations, critical thinking in radiography appears to be better aligned with the training and practice requirements of nursing rather than medicine.

Issues regarding critical thinking in nursing draw parallels with those personally discovered in radiography. One such issue is supported by Daly (2001) who claims that there is no single definition of critical thinking that is widely accepted in nursing literature. This is true for radiography as well. Critical thinking is an abstract concept and there is a need to define it in a discipline-specific manner so that as educators we communicate both the importance and the expectation of developing this skill, as relevant to our discipline. Furthermore, the development of critical thinking skills in nursing is a key requirement of nursing practice just as that expected in radiography practice. Jones and Morris (2007) say that critical thinking is essential for professional accountability and quality nursing practice. Similar to radiography, the necessity for critical thinking skills in nursing has grown as the requirement for autonomy has increased. The reason is that doctors are not always present to make decisions in the clinical environment. As expected within their role, a nurse or radiographer must exercise autonomy in making decisions and these decisions should be made based on experience, scientific knowledge, training, values, and ethics (Jones & Morris, 2007).

Nurses who think critically are argued to value intellectually stimulating situations and are self-confident in their own thoughts (Heaslip, 2008). Similar to radiographers, nurses have to sift through masses of information on a daily basis in order to ensure that the information has been properly utilised to make good decisions. One of the obstacles to thinking critically in practice, as mentioned by Duron et al. (2006), is when nurses are satisfied with taking a passive approach to nursing care. One important component in developing critical thinking skills is therefore to encourage active learning in students. Students need to be able to actively question practice, both in nursing and radiography, in order to seek an understanding of what they are expected to do. The integration of theory and practice forms the cornerstone of both nursing and radiography education and practice; critical thinking is therefore not an isolated part of this process (Duron, et al., 2006). Chan (2013) agrees by saying that educators believe that critical thinkers do not accept information in a cursory way but rather question, seek and examine the questions for answers and deeper meanings. He says that educators are encouraged when they see their students asking questions because this indicates that

students are thinking critically. This might be considered as naïve given that I, as the researcher, do not believe that all students who ask questions are thinking critically. However, the act of questioning is an indication of active learning (Biggs, 2003). Active learners are more likely to develop higher order thinking skills compared with passive learners. This is discussed later in the chapter. I am therefore inclined to accept Chan's (2013) statement on this basis.

Kaddoura (2010) asserts that critical thinking is required to deal with complex care as seen in nursing. This is essential for professional accountability and quality nursing practice (Jones & Morris, 2007). Similarly, due to the complexity of the development of the role of a radiographer, it is argued to be a key requirement for radiography. The practice of radiography and nursing are framed by similar expectations as defined by their respective professional and regulatory bodies. Their similarities lie in the expectations of best practice regarding patient care and autonomous decision-making. Their difference lies in their respective scope of practice which is discipline specific. This is where the originality of my study will add to the body of knowledge in the field of critical thinking relating to the health sciences with a specific focus on the practice of diagnostic radiography.

Furthermore, both professions use criteria in their judgment and decision-making. Both professions are boundaried by their specific parameters, protocols and practice requirements. In diagnostic radiography, for example, practice takes place within a specifically designed environment. This is highly specialised in the context of radiographic practice with the purpose of producing diagnostic radiographic images. Radiographers' views, like nurses, have been informed by the generic meaning of critical thinking, however they work within very specific environments and decisions taken need to be made within these very specific contexts. Both disciplines have been informed by a generic set of critical thinking principles of which Bloom (1956) provided a very useful framework from which to work and is discussed later in the chapter. Bloom's framework provided a common platform from which to build on in relation to how critical thinking develops in radiography. Hence for this study, it is assumed that a similarity between these two professional disciplines can be drawn. In view of this assumption, it is argued that relevant nursing literature can be used to support this study. Lastly, Distler (2007) offers his contribution by saying that critical thinkers in nursing exhibit confidence, creativity, flexibility, integrity, and open-mindedness while practicing their craft. These are attributes and dispositions of critical thinking that both nursing and radiography students are expected to exhibit by their respective professional and regulatory bodies.

2.3.1. Summary

In this section, a rationale for the use of nursing literature within this study is presented. Similar to diagnostic radiography, the necessity for critical thinking skills in nursing has grown as the requirement for autonomy has increased, due to doctors, in nursing, and radiologists in radiography, not always being present. A nurse or radiographer has the autonomy to make decisions; these decisions should be made based on experience, scientific knowledge, training, values, and ethics in accordance with their respective scope of practice. Nurses are required to make decisions in the clinical environment similar to radiographers, their parameters and protocols are very specific to the context within which they practice. Both professions, therefore, share a similar requirement towards needing a discipline-specific definition of critical thinking as well as research into how critical thinking develops within both these fields. Studies used in this dissertation have been drawn largely from nursing research due to its proximity to radiography within a healthcare setting.

2.4. An analysis of definitions of critical thinking

This section presents a historical background to the meaning of critical thinking. This is followed by an analysis of definitions of critical thinking published by six prominent authors from the fields of philosophy, psychology, and education. The rationale for choosing these authors (Dewey,1933; Glaser, 1941; McPeck, 1981; Ennis, 1989) is that they have published seminal work in the field of critical thinking. In addition, I have included Halpern (1989) and Facione (1990). Although the latter two did not publish seminal work, they are included by virtue of their original contributions to the overall dimension of the meaning and application of critical thinking skills. The concepts derived from these definitions are analysed showing the relationship between them. The meaning they attributed to the terms 'critical thinking' contributed to the development of my conceptual framework.

In order to analyse the definitions of critical thinking, it is important to consider the root meaning of its component words. The word 'critical' is an adjective stemming from the Greek words, *kritikos*, which means 'ability to make judgments', and *kriterion* meaning 'standards' (Gupta & Upshur, 2012). Etymologically the words mean the power of discerning judgment based on using standards. The word 'think' is both a verb and a noun. It is used in both contexts. According to The Free Dictionary (2013), to think means to "have or formulate in the mind", "to decide by reflecting or reasoning", "to judge or regard, look upon", "and to suppose". Putting this together, critical thinking appears to mean the following: discerning judgment based on using standards formulated in the mind by reflecting, reasoning, looking upon and supposing.

However, a key defining feature of critical thinking is the ability to think in a logical and abstract manner and to be able to reason (Paul, 1990; Fisher, 2001; Paul & Elder, 2007). I would like to demonstrate the evolution of the meaning of critical thinking from Dewey's definition in the early 1900s to Halpern's definition in the late 1900s.

2.4.1. Historical context of critical thinking

The beginning of critical thinking in relation to logical thinking and reasoning, according to Jones-Devitt and Smith (2007) and Fahim and Bagheri (2012), dates back to the days of Socrates (399-469 BC) from whom the Socratic method of teaching emerged. His method involves teaching by asking leading questions that guide students to discover the subject matter by themselves rather than being given the information (Brickhouse & Smith, 2000). Socrates, according to Benson (2006), was famous for asking questions in a tactful way even to the extent of answering a question with a question. The intention behind this method of questioning was believed to create doubt in the mind of the questioner leading them to question their own points of view in light of Socrates' questions. Through this, he encouraged his students to think of alternatives and weigh up assumptions in order to look for new meaning that did not appear obvious. On cross-examination, however, Socrates also succeeded in bringing out the weaknesses of his questioners in addition to assessing whether their set of beliefs were mutually consistent (Kost & Chen, 2015). Although Brickhouse and Smith (2000) state that most of Socrates' questions were borne of ignorance, this idea gave birth broadly to the concept of questioning and not simply believing what one is told. Critical thinking therefore appears to have been first introduced by Socrates, although he did not call it that; it helped his students develop a "deep level of understanding" through the questioning of different viewpoints, assumptions, their underlying beliefs and consequences (Fahim & Bagheri, 2012: 1123). This method of teaching stimulated students' thinking abilities and reasoning abilities and helped examine opinions which in turn helped to build new knowledge and understanding from previous knowledge. However, tutors need to have the skill to conduct questioning by asking appropriate questions (Fahim & Bagheri, 2012).

2.4.2. From John Dewey (1933) to Peter Facione (1990)

In the 20th century John Dewey (1933), who had a background in philosophy, psychology, and education, drew attention to thinking about issues because of a result of ambiguity in meaning and suggested that we think about how we think. Called by Sternberg (1986: 3) the modern-day founder of the "critical thinking movement," and by Fisher (2001: 2) the "father of the modern critical thinking tradition," Dewey believed that critical thinking was one element of the broader reflective framework involving "assessment, scrutiny and conclusion" (Dewey,1933:

6). He felt that the main purpose of critical thinking was to inject an element of scepticism and rigour, without judgment, as appropriate. Dewey's position on the concept of reflection in relation to critical thinking is that critical thinking is "reflective thinking" (Dewey,1909: 9). He defined it as:

> …active, persistent and careful consideration of a belief or supposed form of knowledge in the light of the grounds which support it and the further conclusions to which it tends (Dewey, 1909: 9).

By using the term 'active' in his definition, Dewey drew a comparison between active and passive thinking as the latter means inactive (Biggs, 2003). Through this he was saying that critical thinking is not passive thinking; one has to take an active part in the thinking process. If active thinking is considered to be critical thinking or reflective thinking, according to Dewey's definition, then passive thinking can be likened to unreflective thinking which happens when one "jumps to conclusions or accepts evidence, claim or decision at face value" where there is no proper thinking about the issue (Fisher, 2001: 14). Dewey's belief was that critical thinking is an active process where you think for yourself, you raise questions by yourself, find out about something by yourself rather than following someone else's lead. He went on to say that the thinking must be persistent and careful, implying that we should not aim to conclude the problem when signs of the first likely solution may appear; we have to consider likely solutions carefully. The word 'careful' means "making sure of avoiding potential danger, mishap, or harm and anxious to protect something from harm or loss" (Oxford Dictionaries, 2018c). In some instances, we do need to make very quick decisions on the spot, for example, what to prepare for dinner. However, the message in his definition is that critical thinking involves more persistent and careful thinking as described above, as opposed to quick thinking. Because persistent and careful thinking takes time and patience among other attributes, it is possible that one may find the process difficult or troublesome as Dewey explained:

> …reflective thinking is always more or less troublesome because it involves overcoming the inertia that inclines one to accept suggestions at their face value; it involves willingness to endure a condition of mental unrest and disturbance (Dewey, 1909: 13).

In relation to what Dewey said "inertia" could mean the habitual thinking patterns which people choose. It implies a lack of action which makes people complacent and they choose to accept information at face value. 'Face value' can mean superficial thinking which may be choosing an easy, obvious option. There is no criticality of thought when choosing an easy option. Critical thinking is about having a persistent and disciplined thought process as previously alluded to by Dewey, therefore it is considered to be tedious or as Dewey says, 'troublesome' involving 'mental unrest and disturbance.' Thinking, therefore, can be critical or uncritical depending on the choices we make.

In his definition, Dewey also speaks about a belief or a supposed form of knowledge. Here this could mean the problem at hand, for example, a differing point of view. He speaks about the grounds which support it, meaning the reasons for the belief. Having sound reasons to justify our arguments lend an element of validity to claims made. By this, it is meant that people are more likely to believe you if you give them sound or good quality reasons to justify your point of view. In radiography, in order to ensure best patient outcomes, radiographers must evaluate reasons thoroughly in their decision-making processes. The skilful reasoning is a key element of critical thinking (Fisher, 2001).

However, Dewey's teaching of critical thinking does not stop there. He professed that one should withhold judgment until there is clear evidence available to direct one's thinking in order to decide what one should believe or not, and that, that is the challenging part of critical thinking. "Reflective thinking, in short, means judgment suspended during further inquiry; and suspense is likely to be somewhat painful" (Dewey,1991: 13). In addition, he stated "to maintain the state of doubt and to carry on systematic and protracted inquiry are the essentials of thinking" (Dewey, 1991: 13). This implies that although most people tend to sum up a situation fairly quickly in order to move on, he suggested that being able to dwell on a matter and maintaining a state of doubt while investigating the matter ('protracted inquiry') are crucial to the thinking process. Furthermore, he explained that "if the suggestion that occurs is at once accepted, we have uncritical thinking" (Dewey, 1991: 13). There is therefore a very clear distinction emanating from Dewey as to what he considered to be critical thinking and what is not critical thinking. In summary, Dewey's definition of critical thinking involves active, continual and conscientious consideration of a point of view or a problem in light of the underlying reasons that support the belief.

Later in the twentieth-century, building on from Dewey's work, was Edward Glaser (1941). He had a background in psychology and was famous for his involvement in the development of the critical thinking measurement test instrument, The Watson-Glaser Critical Thinking Appraisal tool which was published in 1952 (Watson & Glaser, 1964). This test, according to Ennis (1958: 155) has "advanced the frontier in the measurement of critical thinking skills." Glaser's definition of critical thinking is as follows:

> …an attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experience; knowledge of the methods of logical enquiry and reasoning and some skill in applying those methods. Critical thinking calls for a persistent effort to examine any belief or supposed form of knowledge in the light of evidence that supports it and the further conclusions to which it tends (Glaser, 1941: 5).

Consideration of this definition in comparison to Dewey's one above, reveals a number of similarities in meaning. For example, 'to consider in a thoughtful way' is likened to Dewey's 'careful consideration'. Indeed, the latter portion of the definition is distinctly similar to the wording in Dewey's definition with the exception of the word 'evidence' in Glaser's definition replacing Dewey's 'grounds'. What is different in Glaser's definition are the words 'an attitude of being disposed to.' 'Attitude' is described as: "a settled way of thinking or feeling about something, and/or a position of the body indicating a particular state of mind" (Oxford Dictionaries, 2018d). 'Disposition' is defined as "a person's inherent qualities of mind and character", and as having "an inclination or tendency" towards something (Oxford Dictionaries, 2018e). This implies that for Glaser critical thinking involves having an attitude of being inclined towards ('disposed to') the consideration of problems in a thoughtful way. As such he believed that a person may have the skills of critical thinking but may not be inclined to use them. For example, a person might be skilled in art but may not be inclined to draw. This is the first indication we are seeing of 'dispositions' being linked to the definition of critical thinking. This is a very important development in the definition and is revisited later in this chapter. Glaser (1941) speaks of 'methods of logical enquiry' which may mean questioning and reasoning around the problem, similar to Dewey. Glaser also spoke of having 'some skill' in the 'method of applying' reasoning. 'Skill' is defined as "the ability to do something well, or have expertise" (Oxford Dictionaries, 2018f). This may allude to the ability to handle reasons or evaluate reasons in a skilful way. However, interestingly he spoke of 'subjects that come within the range of one's experience' implying that one must have prior experience of the 'problems and subjects' in order to be able to consider them in a thoughtful way. This again is similar to Dewey when he said that in order for thinking to take place, there must be knowledge about the problem. Knowledge in this sense would be knowledge of the problem or subject that the person already has, i.e. prior knowledge. In this way it could be likened to 'experience' that Glaser spoke of. Glaser's definition is similar to Dewey's in terms of skills, but he added the dimension of critical thinking having an attitude of being disposed towards considerations. Critical thinking, therefore, from Glaser's perspective, involves both the skills of critical thinking ('methods of logical enquiry' and 'skill in applying those methods') and the mannerism ('attitude') of being inclined ('disposed') towards thoughtful considerations.

Thus far a meaning of critical thinking from both Dewey and Glaser has been built. The third definition that was considered was from John McPeck, who had a background in philosophy and psychology. He defined critical thinking as "the propensity and skill to engage in an activity with reflective scepticism" (McPeck 1981: 8). Critical thinking is a vague concept. It is not well understood. However, the authors thus far agree that critical thinking is thinking of some sort. As such literature has been dominated by psychologists' views on the topic which were mainly

centred on inductive and deductive reasoning, or specific types of decision making (McPeck, 1981).

In relation to 'reflective scepticism' in McPeck's definition, he explained that the point of this is not to disagree but rather to look at ways to solve the problem at hand. 'Reflective' in the definition refers to the "level of deliberation" (McPeck, 1981: 9) in the thinking process which is similar to Dewey's 'reflective, careful thinking'. It is about how much and what quality of thought has gone into the thinking process in order to consider what alternative methods or techniques can be employed. Similar to Dewey's 'in light of the grounds which support it and the further conclusions to which it tends', McPeck asserted that 'scepticism' should be exercised before one decided what to accept as believable. One of the skills of critical thinking is scepticism (as mentioned above) towards a statement, information or a way of doing things, which prompts questioning in a way that Glaser called 'methods of logical enquiry'. In radiography this would relate to the evaluation of clinical information in relation to the diagnostic information required; the benefit of the examination in relation to the risk of ionising radiation, and the overall justification of the examination. It encourages one to consider alternatives/ options and not simply accept what one is being presented with for granted. In routine radiographic practice, one follows a protocol and there is certainty in the examination procedure to follow. However, in relation to situations that present complexities that are outside of the protocol or routine expectations, for example in complex radiographic examinations, the skills of reflective scepticism are required.

In order to apply reflective scepticism one requires knowledge of the subject area and the "propensity" (McPeck, 1981: 7) to use the skill. 'Propensity' is defined as "an inclination or natural tendency to behave in a particular way" (Oxford Dictionaries, 2018g), and draws parallels with Glaser's words, 'an attitude of being disposed of.' With regard to developing the 'propensity' to use the skill, this needs to develop from the students' attitude to learning. However, the students' attitude to learning is influenced by tutors' attitude to teaching as well as the teaching environment (McPeck, 1981). This raises the following question. How conducive are our environments in supporting the development of critical thinking skills and attitudes? Williams (2016) says that students are encouraged to see themselves as vulnerable. Universities, she alleges, are becoming dominated by conformity and consensus where academics do not want to say anything controversial at all. As tutors, do we teach controversially, or do we shy away from controversial subjects? From *personal* experience we appear to keep to the norm, i.e. the 'straight and narrow' and this appears to limit critical thinking according to Williams (2016). This leads to the following question. How are our

students going to develop their skills of critical thinking if we as tutors are not actively using ours in our teaching practices?

McPeck also states that "thinking is always thinking about something" (McPeck,1981: 3): to think of nothing, he says, is a "conceptual impossibility" (McPeck,1981: 3). This leads to the question, "can we teach students to think?" The answer is no, but we can teach them to think about something because thinking is always thinking about something. If 'something' is an X then thinking is logically connected to X. Thinking is therefore logically connected to something. This could be a problem, situation, activity or subject area in radiography. It would appear, therefore, that the word 'critical' is what has caused the confusion among the myriad definitions of critical thinking in the published domain. If, according to McPeck (1981), we understand that 'thinking' is thinking about something, and that the word 'critical' is an adjective used to describe thinking, adding the word 'critical' to the word 'thinking' merely describes that way of thinking about something, i.e. a critical way of thinking, hence critical thinking. Could understanding the meaning of critical thinking be that simple? If so, why do we as tutors' struggle to explain its meaning to students? Furthermore, McPeck says that for tutors to say that they teach critical thinking is "vacuous because there is no generalised skill called critical thinking" (McPeck,1981: 5). Critical thinking, therefore, cannot be taught as a distinct subject. This calls into question the critical thinking modules that university courses offer and raises another question, "what is being taught as critical thinking?"

McPeck therefore, similar to Dewey and Glaser, believes that critical thinking is always connected to "some identifiable activity subject area" (McPeck,1981: 5) which is radiography in this case. As some activities may be done very well and some may not, in the same way, the activities can be done critically or uncritically (Dewey, 1933). This valuable point has significance for the practice of radiography as some examinations may be conducted very well while some may not. In addition, because critical thinking is thinking in a specific area, a critical thinker in one subject area may not be a critical thinker in another subject area. My view is that it depends on what we classify as an academic subject. If one subject is diagnostic radiography and the other is physiotherapy, then critical thinking from the former to the latter subject is not transferable, due to the difference in expectation of the knowledge required in each of those subjects. However, if the subject is diagnostic radiography, then critical thinking within areas of this subject will be transferable. Critical thinking is therefore subject specific, and the component skills and dispositions of critical thinking can be applied to various areas within the subject. What is different, therefore, in McPeck's definition is that critical thinking is subject specific but can be applied in a variety of ways. This is an addition to the definition developed thus far.

The fourth definition that is considered is from Robert Ennis (1989), who according to Fisher (2001), is one of the most famous contributors to the topic of critical thinking and whose definition is the most widely applied across various disciplines. He has a background in philosophy and education, and defined critical thinking as:

> …reasonable, reflective thinking that is focused on deciding what to believe or do (Ennis, 1989: 4).

He described it further as a process, the goal of which is to make reasonable decisions about what to believe and what to do. Ennis's definition is similar to the above discussed ones of Dewey, and Glaser, in the use of the words, 'reasonable and reflective thinking that is focused.' However, Ennis speaks about 'deciding what to believe or do' which appears suggestive of making a decision on what to believe or do. 'Or do' also implies that one must do something, e.g. take action. Furthermore, he likened the thinking required as a process whose end target was a goal, a goal of what to believe or do. This implies that the goal or the purpose of the thinking process is to make a decision. This is yet another addition to the development of the definition seen thus far.

Ennis (1993) also believed that a person's abilities to develop critical thinking depended on certain dispositions made up of attitudes and inclinations, similar to Glaser and McPeck. He encouraged students to be reflective about their abilities and develop their dispositions so that they were able to use them interdependently when faced with a real situation. The disposition to care about others' dignity and welfare is not part of the definition of critical thinking, but Ennis (1996) argues that in order for thinking to be humane, it is desirable for all critical thinkers to possess this as lack of it makes critical thinking less valuable. This is of particular importance to the ethical practice of radiography as due care and regard for a patient's dignity and welfare needs to be considered. Again, this has implications for ethical and moral reasoning for learning and application of knowledge to clinical practice.

Ennis (1989) however, also described critical thinking as the assessment of statements. From the understanding derived from McPeck's (1981) definition, critical thinking appears to be much more than an assessment of statements. As seen in the subject-specific nature of thinking, critical thinking may be required in activities or skills that do not necessarily use statements, e.g. art, music, games like chess and sport. Apart from statements, these activities use methods and techniques that require critical thinking as McPeck says "doing things like problem-solving and using methods often requires as much critical acumen as assessing statements within or about these activities" (McPeck,1981: 10). Therefore, in light of McPeck's view, Ennis's statement appears short-sighted in relation to the very insightful definition given

earlier. My thoughts, however, are that critical thinking may be applied to the assessment of statements depending on situation or context it is applied in, e.g. writing coursework assessments but not limited to this. Perhaps this is what Ennis implied?

The fifth definition considered is from Diane Halpern (1989). Halpern, who has a background in psychology, defined critical thinking as:

…thinking that is purposeful, reasoned and goal-directed (Halpern, 1989: 5).

Halpern's definition implies that the thinking process is 'purposeful and goal oriented' similar to Ennis. Halpern further explained that it is the type of "thinking that is involved in solving problems, formulating inferences, calculating likelihoods and making decisions" (Halpern, 1989: 5), when the thinker is using skills that are thoughtful and effective for the particular context and type of thinking task. The 'critical' part of critical thinking should involve an evaluative component comprising a constructive reflection of positive and negative attributes.

Halpern (1989:5) also calls critical thinking "directed thinking" due to its focus on "obtaining a desired outcome". In contrast, she refers to the thinking that underlies daily routine habits such as brushing teeth or taking the same route to work, as "non-directed thinking" where the action is largely mechanical requiring little conscious evaluation. These terms can be likened to Dewey's (1933) active thinking (directed) as compared with passive thinking (non-directed). According to Halpern, most people have "very little awareness of the nature or even the existence of the thinking processes that underlie their judgments, beliefs, inferences, and conclusions about complex issues" (Halpern, 1989: 31). Halpern, therefore, asserts that one needs to develop mindfulness or awareness in order to direct one's attention to the processes and products of one's own thoughts, and being mindful requires a self-conscious concern for and evaluation of the thinking process. Thus, in addition to the similarities with the definitions already discussed, Halpern's definition (1989) adds in the cognitive skills of solving problems, formulating inferences, calculating likelihoods and making decisions. Halpern also speaks of metacognition where this refers to what we know about what we know. It is about our knowledge about knowledge. Early metacognitive experiences serve as the foundations for the higher-order thinking that appears at a later stage (Kuhn, 2000). Metacognition is defined as an "awareness and understanding of one's own thought processes" (Oxford Dictionaries, 2018h), which Dewey (1933) calls 'thinking about our thinking.' In addition to the cognitive skills, Halpern adds the dimension of metacognition to the meaning of critical thinking.

The sixth prominent author that I have chosen to include within this review is Peter Facione (1990), who has a background in philosophy. Facione, on the recommendation of the American Philosophical Association (APA) led a Delphi study in 1987 to review the meaning

of critical thinking. A Delphi technique is a systematic forecasting method that involves structured interaction among a group of experts on a subject (Business Dictionary, 2018a). This can take place during multiple rounds until pre-defined criteria are reached which enable group of experts to arrive at a consensus forecast on the subject being discussed (Business Dictionary, 2018a). The Delphi study led to the definition which summed up critical thinking as:

> …purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference as well as explanation of the evidential conceptual, methodological, criteriological or contextual considerations upon which that judgment was based (Facione, 1990: 3).

This definition has a number of similarities with those already discussed e.g. purposeful judgment, explanation of the evidence and contextual considerations upon which judgment was based. In addition, the experts in the Delphi study suggested the following:

> …the ideal critical thinker is habitually inquisitive, well-informed, honest in facing personal biases, prudent in making judgments, willing to consider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in selection of criteria, focused in inquiry and persistent in seeking results which are as precise as the subject and the circumstances of inquiry permit. It combines the development of critical thinking skills with nurturing those dispositions, which consistently yield useful insights and, which form the basis of a rational and democratic society (Facione, 1990: 3).

According to Facione (1990) the basis of a natural, democratic society lies in the development and use of critical thinking skills. Ennis (1993), in comparison, argues that although these words may not be present in the definition of critical thinking, critical thinkers should also take into account the 'care and welfare of others' as seen above. It is important to note, that in defining critical thinking, authors are unable to separate the dispositions which they consider a vital link to being able to make a good critical thinker. Facione's definition, although lengthy in the description, concurs with those already discussed. What this adds, however, is the affirmation that the development of critical thinking skills cannot take place without 'nurturing those dispositions.' The dispositions to care and consider the welfare of others, honest in relation to personal biases, willingness to consider, being diligent and so on, as mentioned above, are not cognitive skills, these are known as affective skills. The skills for critical thinking, therefore, include not just cognitive as identified by Dewey (1933), McPeck (1981) and Ennis (1989) in their respective definitions above, but a consensus of the affective skills is seen which concurs with Glaser (1941), Halpern (1989) and Facione (1990).

Although Halpern does not use the term 'disposition' within her definition, however, she posits that critical thinking requires an attitude where thinkers are motivated and willing to exert conscious effort into their thought process when solving problems; developing a critical thinking attitude is as important as developing thinking skills (Halpern, 1999). One of the major

differences between good and poor thinkers and correspondingly good and poor students is their attitude (Halpern, 1999). Many errors occur not because people cannot think critically, she says, it is because they do not. Congruent with the views of Ennis (1989) and Facione (1990), Halpern (1999) agrees that attitudes and dispositions are central to the development of critical thinking skills Furthermore, Dewey's 'careful consideration' makes a strong case for students to use reasons in their thinking processes. Likewise, students will need to exercise objectivity in their judgment in order to inform their decision making. Students' respective attitudes are likely to affect their judgment which may then affect their decision-making ability. These dispositions are revisited later in this chapter. However, it is important to draw attention to the evolution of the meaning of critical thinking from including just the very specific cognitive thinking process to definitions that include affective skills and the disposition (inclination) towards using the skills.

Fisher (2001) says that thinking is not critical just because it is intended to be, any more than when authors like Dewey who claim that thinking is scientific just because it aims to be. He argues that for thinking to be critical, it "has to meet certain standards of clarity, relevance, and reasonableness" (Fisher, 2001: 11), and one may be more or less skilled in doing this. However, one can only be good at critical thinking if being able to understand what is required by it and can do it. I agree, therefore, with Johnson and Hamby (2015) who argue that the problem with understanding the meaning of critical thinking lies not in the problem that there are no good definitions on the concept of critical thinking. There is rather an overabundance of definitions in literature today. Although overabundant, the definitions appear overworked yet under-analysed (Johnson & Hamby, 2015). Could this perceived under-analysis be the reason why despite the myriad of meanings attributed to critical thinking, disagreements exist regarding its nature and application? In a study conducted by Geng (2014), sixty-four definitions were analysed and the following keywords were summarised as the nature of critical thinking, namely: judgment, argument, questioning, problem-solving, information processing, meta-cognitive, skill and disposition (Geng, 2014: 125). When evaluating the various definitions of critical thinking, they amounted to a collective agreement of simply assessing information, statements, and arguments (Geng, 2014). This definition, in comparison to the definitions from authors previously analysed, appears not only vague but also an oversimplification of a rather complex construct. Ennis (1993) warns against oversimplifying the meaning of critical thinking as there is the danger of removing the creative aspects of considering alternatives, formulating hypotheses and conclusions. This, on the contrary, is interesting advice from Ennis considering that he controversially described critical thinking as assessment of statements earlier on. Nonetheless, there is a need to "refine its

conceptualisation", and critical thinking can, therefore, be considered as a "construct in transition" (Geng, 2014: 124).

Gosnell (2010), in her study, concluded that critical thinking is a vital skill which must be included in radiography training programmes; that there is a need for a definition of critical thinking as applicable to radiography. Due to the vast amount of literature on critical thinking, it is assumed that critical thinking can be taught. However, published work has not yielded conclusive evidence on how critical thinking develops (Banning, 2006). Therefore, despite the abundance of meaning attributed to critical thinking, it suffers from a lack of conceptualisation as required for our specific professional disciplines. This is where the originality of my study lies: in providing a contextual meaning of critical thinking in diagnostic radiography.

2.4.3. Summary

In this section, the historical context of critical thinking and definitions from six prominent authors in the field of critical thinking was reviewed. The analysis demonstrates the evolution of the meaning of critical thinking from Dewey's definition in 1933, to Facione's in 1990. The meaning of critical thinking developed from a purely cognitive definition to one that includes both the cognitive skills and affective dispositions of critical thinking.

The next section presents the conceptual framework of the study.

2.5. Conceptual framework

In this section, the conceptual framework of the study is presented. A conceptual framework, according to Business Dictionary (2018b), is "a theoretical structure of assumptions, principles, and rules that holds together the ideas comprising a broad concept." Differences exist in the way in which critical thinking is defined in the literature as explained earlier. Almost every renowned educational scholar has a definition of critical thinking by which they attempted to educate, clarify and demystify the meaning attributed to critical thinking over the previous centuries (Geng, 2014). Critical thinking consequently has been defined within the literature in multiple ways. Because of the multiplicity of publications in this field, I have limited the definitions I had used within this conceptual framework to the afore-mentioned authors and previously justified their inclusion within this study. The conceptualisation of their definitions forms the framework for this study:

active, persistent and careful consideration of a belief or supposed form of knowledge in the light of the grounds which support it and the further conclusions to which it tends (Dewey,1909: 9)

an attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experience; knowledge of the methods of logical enquiry and reasoning and some skill in applying those methods. Critical thinking calls for a persistent effort to examine any belief or supposed form of knowledge in the light of evidence that supports it and the further conclusions to which it tends (Glaser,1941: 5)

the propensity and skill to engage with in an activity with reflective scepticism (McPeck,1981: 8).

reasonable, reflective thinking that is focused on deciding what to believe or do (Ennis,1989: 4).

…thinking that is purposeful, reasoned and goal-directed (Halpern, 1989: 5)

…purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference as well as explanation of the evidential conceptual, methodological, criteriological or contextual considerations upon which that judgment was based (Facione, 1990: 3)

Despite the differences from the three main thought domains of philosophy, psychology, and education, there are common expressions among them. All three perspectives believe that critical thinking involves the main components of reason, reflection, purposeful thinking, and morality. The first component rests on the concept of **reason** where there is willingness and confidence in the ability to reason and disciplined mental activity. The second component rests on the concept of **reflection** on positive and negative attributes in deciding what to believe or do thereby being honest in facing personal biases, and prudent, and objective in making judgements, and evaluating arguments or propositions. The third component rests on the concept of **purposeful** thinking that is goal oriented, focussed in inquiry and persistent in seeking results, and that which will guide the development of beliefs. The fourth component rests on the concept of **morality** whereby there is care about others' dignity and welfare while considering various insights for consensus-seeking using collaboration for agreement thereby upholding standards and values inherent in educated thought and taking action. In addition, for critical thinking to be actuated, according to Glaser (1941), Halpern (1989) and Facione (1990), a thinker must possess the skills and the inclination to apply those skills. The skills and dispositions required for critical thinking development are discussed in Section 2.7, p. 42.

 As detailed in Chapter One, a radiographer's role involves the provision of quick and accurate imaging examinations and diagnosis in a range of clinical areas within a hospital setting. The use of critical thinking skills is crucial in making ethically sound decisions for best patient outcomes. On searching literature on the meaning of critical thinking, it is evident that authors have over the years attempted to attribute meanings to 'critical thinking' as discussed earlier

in this chapter. However, there is no 'best fit' definition of critical thinking that can be easily understood and applied to learning and teaching in HE (Paul, 1990; Kuhn, 1999; Moon, 2008). As educators, we tend to use a published definition by moulding it to our local requirements (Kuhn, 1999). Scheffer and Rubenfeld (2000) maintain that a concise definition of the concept of critical thinking is one that various disciplines continue to struggle with today. In order to successfully advise students in the development of this core skill, it is therefore important that academics have a clear understanding of the meaning of critical thinking (Castle, 2009). However, developing a single definition has been problematic due to the subjective nature of the interpretation attributed by various authors. These authors have reasoned their articulations of critical thinking. Each needs to be appreciated on its own merit. None have explicitly stated that 'this is the correct definition' to follow although some have been criticised in the literature for professing to be correct (Banning, 2006).

Due to critical thinking being subject specific rather than generic, it would be feasible to build on the meaning suggested by student and tutor participants in light of these published definitions but with specific relevance to radiography education and practice. My framework is therefore based on an articulated understanding of the breadth of meaning attributed to the generic definitions as well as the discipline-specific requirements of the practice of diagnostic radiography. The conceptual framework acted as a reference point when exploring participants' understanding of the meaning of critical thinking, and in relation to the analysis and interpretation of data.

2.5.1. Summary

This section presented my conceptual framework for this study which is grounded in the analysis of published definitions of critical thinking and in the expectation for the practice of the autonomous diagnostic radiographer. The concepts underpinning their definitions are discussed later in the dissertation in relation to the findings of the study to answer the research questions, and with the aim of closing the current gap that exists within the published domain regarding a discipline-specific definition of critical thinking in diagnostic radiography.

The next section focuses on the development of critical thinking.

2.6. The development of critical thinking skills

The purpose of this section is to describe the development of critical thinking skills in relation to Bloom's taxonomy of the cognitive domain. There is no published empirical research on

how critical thinking skills develop in a learner (See Section 2.2.). I therefore consulted the work of Bloom (1956). Only the cognitive and affective domains of Bloom's work have been included in this section. Reference to the psychomotor domain does not have immediate relevance to this study and was therefore excluded.

Benjamin Bloom was not a philosopher, but no educational research into thinking skills is complete without an acknowledgment of his work. Bloom (1956), an educational psychologist, together with a select group of other educators developed a set of educational objectives which later became known as a taxonomy: the taxonomy of the cognitive domain remains his most recognised work (Anderson, 2002). However, Bloom's work involved more than just a taxonomy into the cognitive domain, which was Handbook I. His work also includes educational objectives relating to the affective domain (Handbook II) in which he addressed the attitudes that teachers should instill in their students (Booker, 2007). Although Booker (2007: 349) stated that he found Handbook II to be a more "intriguing document", the handbook is not well published. The third taxonomy, Handbook III relating to the psychomotor domain, similarly is not well published. A taxonomy, according to Larkin and Burton (2008), is a type of developed classification system to help tutors classify learning objectives and skills for students. Bloom's taxonomy is depicted as a hierarchy of cognitive learning levels (see Figure 1), beginning from a knowledge base rising sequentially to advanced levels of cognitive thought processes involving analysis, synthesis and evaluation. His taxonomy is presented as a means of helping students develop their learning to higher more sophisticated levels of understanding which he believed students could attain if proper learning conditions were facilitated (Anderson, 2002).

Bloom's taxonomy of the cognitive domain influenced the development of the 2001 SEEC level descriptors. The SEEC descriptors provide a description of levels of learning through a hierarchy of knowledge and skills which contextualise the learning that is expected at each level of the programme of study and consequently enables assessment of learning outcomes. In this way, the SEEC level descriptors remain aligned to Bloom's taxonomy. Bloom's classification and hierarchy of thinking skills is therefore firmly embedded within the culture of many universities today having influenced assessment and learning outcomes over the years. The descriptors were rewritten in 2010 following revision of the criteria. They were updated in November 2016 to reflect changes in the sector. The descriptors themselves, however, remain unchanged (SEEC, 2016). See APPENDIX 2 for the descriptors detailing the requirements at Level four, five and six in higher education. The taxonomy with its six successive levels is presented below in Figure 1.
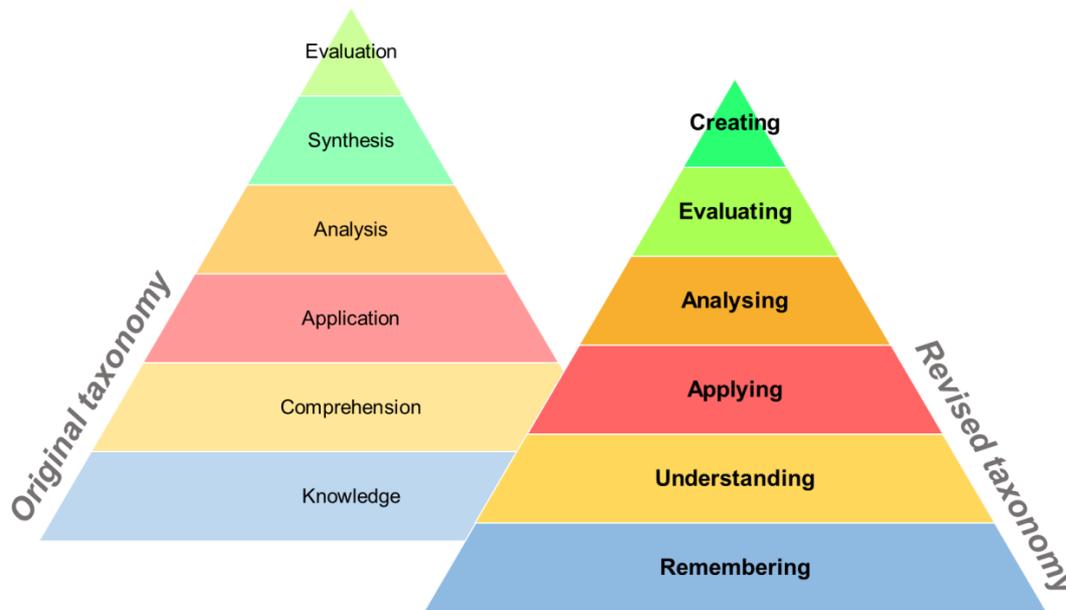
Figure 1. Bloom's taxonomy of educational objectives. The classification of educational goals, Handbook I: cognitive domain (adapted from Anderson & Krathwohl, 2001)

The figure above illustrates the original taxonomy and the revised one. According to Anderson and Krathwohl (2001), revisions were made in order to refocus educators' attention to the value and original intention of the Handbook with the hope of limiting its misuse. The second reason to update the framework was to include new knowledge and thought, as society and the curriculum had moved on over the last fifty years thus it was timeous for change. The revised version, according to Seaman (2011), does not replace the original version. It does however provide an educator with a choice of using either, acknowledging the fact that curriculum has changed and so has the use of the taxonomy. Although a number of changes were made during the revision of the taxonomy (given below) the two main changes were the change from nouns to verbs, which are used to describe the different levels within the taxonomy, and reversal of the two highest levels. The reason for the first change was to emphasise the active cognitive behaviours desired from students and to facilitate its use by educators in their design and implementation of the curricula (Anderson & Krathwohl, 2001). The words 'knowledge, comprehension and application' changed to 'remembering, understanding, applying.'

The next change seen was the reversal of the two highest levels in both versions above, i.e. 'synthesis and evaluation' which were renamed 'evaluating and creating'. Huitt (2011) states that since no research evidence has been provided for this change it can be argued that the two highest levels are of equal complexity. Huitt (2011) goes on to say that both 'synthesis' and 'creating' involve putting together information which results in new information, whilst

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'evaluation' requires the comparison to an accepted standard where there is an appraisal of how good something is. This change implies that both processes are valuable while neither is superior, therefore omission of either from the critical thinking process will affect the strength of the thought process. 'Analysis' interestingly remains unchanged implying that in the hierarchy of the thinking process analysis is the basis of evaluation.

Another change was the overall structure of the taxonomy from the one-dimensional model seen above to a two-dimensional model (not included). The latter is comprised of a separate knowledge dimension, consisting of four categories, and the cognitive process dimension, comprising the six categories of the model above (Anderson & Krathwohl, 2001). The knowledge dimension is presented as a continuum from factual knowledge, developing to conceptual, leading to procedural and culminating in metacognitive knowledge. (Dwyer et al., 2014). Anderson and Krathwohl (2001: 44) explain that metacognition in this model refers to strategic knowledge, knowledge about cognitive processes and tasks, and self-knowledge, i.e. "one's own cognition and about oneself in relation to various subject matters." Even though metacognition was not used in Bloom's taxonomy given in Figure 1, many conceptualisations of the term are used in relation to the higher order thinking skills described by Bloom. For example, analysis and evaluation are linked to self-regulated thinking which allows one to self-correct his/her thinking based on their evaluation of their thought processes (Halpern, 1989). The self-regulatory functions of metacognition encompass broadly a number of dispositions required for critical thinking, e.g. willingness to conduct one's cognitive skills, the inclination towards good thinking where good suggests the initiative to seek better judgment and the motivation to think and learn (Dwyer et al., 2014). Therefore, metacognition is related to the development of higher order thinking skills.

In relation to the hierarchical structure of the taxonomy, Huitt (1998) states that research claims that the first four levels are indeed a true hierarchy whereby knowing at the knowledge level is easier than and subsumed under the level of comprehension and so on up to the level of analysis. In comparison Eddins (2006) offers that the levels are layered and that the lower layers are related in a hierarchical order; this supports the higher layers which are the critical thinking processes. Eddins did not feel that Bloom intended the higher levels of the taxonomy to be considered as a hierarchy in the sense that achievement of learning at one level leads to the development of learning at the next level higher up. He explained that the "higher level critical thinking skills are networked and can operate in parallel" (Eddins, 2006: 2). However, the next two levels of comprehension and application are sometimes added in. In agreement, Ennis posits that these levels are not hierarchical as suggested by the theory but are interdependent. An example given by Ennis (1993: 179) is that "although synthesis and

evaluation generally require analysis, analysis generally requires synthesis and evaluation." This means therefore that a radiography student who can make a judgment about how to apply a solution to a complex problem is probably working at the evaluation level, and one who is very good at sorting information to create a whole understanding is working at the synthesis level. It is possible therefore to analyse and evaluate information at the same time thus it is possible that these skills can work in parallel with each other. Furthermore, the higher order levels of the hierarchy, based on Ennis', statement are not mutually exclusive therefore it is possible that one could use one or two together in different sequences according to the subject being dealt with.

Nonetheless, being analytical and evaluative are recognised and supported by research as core components of critical thinking (Chan, 2013). This is seen in the skills suggested by both Halpern (1989), and Facione (1990) and affirmed by Ennis (1993) where he says that the upper three levels of Bloom's taxonomy, i.e. analysis, synthesis, and evaluation are often offered as definitions of critical thinking. Bloom's taxonomy also implies that lower order thinking skills of remembering, understanding and applying provide the foundation for the development of higher order thinking skills of analysing, evaluating and creating. The hierarchical nature of his taxonomy implies that for critical thinking skills to develop a student must first have the knowledge as the foundation of learning. This is similar to the views of both Dewey (1933) and McPeck (1981). The process involves remembering what students learned and through this recall of past knowledge they are able to move up the learning ladder to the next level, which is 'understanding'. Here they are expected to demonstrate their ability to make meaning of the subject through their ability to identify or explain and so on. These two stages currently form the basis of learning outcomes on the researcher's programme, as well as being used in programmes nationally. So, having grasped the basis of knowledge and established their level of understanding, the third step takes us to the skill of application where students will typically demonstrate their ability to carry out a task, before embarking on the steps leading to the more abstract thought processes of analysing, evaluating and creating. This description implies a straightforward linear process of learning and development. As a tutor, my sentiment is that learning is not a linear process. If it were then my students would have developed this skill. Developing these skills is an area that they struggle with. However, this is an area for further investigation and a unique aspect of this dissertation.

It is understood from Sternberg (1986) that the benefit of the educational approach using Bloom's taxonomy, was observed in student learning over many years of implementation. Bloom's taxonomy was criticised due to its lack of clarity that was necessary to guide teaching, learning, and assessment in a way tutors found useful. A reason for this could be that

frameworks in education were not rigorously tested as compared with those developed within the philosophical or psychological disciplines (Ennis, 1985; Sternberg, 1986). Although educators used the taxonomy in a variety of ways, according to the authors, it was intended to be used for test construction and assessment following which it gave the educators a good description of the students' behaviour in relation to answering test questions. The students' responses, following the test, were perceived to have represented the "intended outcomes of the educational process" (Bloom, 1956: 12). The taxonomy *per se* was not without criticism. Pring (1971, in Seaman, 2011: 33) asserted that the taxonomy did not provide great help to teachers in the classroom due to being unable to "properly communicate the full scope of education", and "operating with a naïve theory of knowledge". Seaman (2011) posited that whilst this may be true, he argued that the main purpose of the taxonomy was curriculum and assessment with no claim to fully examine knowledge or education. Seaman affirmed that the taxonomy of the cognitive domain was purposefully structured to standardise the grading classifications for various disciplines. Bloom's work involved interdisciplinary course and comprehensive examinations which were retrospective examinations rather than integral learning tools within the learning process its self (Booker, 2007). Therefore, the development of knowledge or the development of learning, according to Booker, appears outside the remit of Bloom's taxonomy. In another controversial debate, Paul (1993) argued that the taxonomy is invalidated because of its misuse. However, he does not say how this has been misused apart from offering that it is neutral, and educators use it without questioning. Paul feels that there are differences between the higher order thinking skills within the taxonomy and critical thinking skills. In his definition of critical thinking, Paul links intelligence with the meaning of critical thinking and intelligence is not included within the definitions of the higher order thinking skills within the taxonomy.

According to Paul (1990: 55) higher order thinking "stimulates and empowers" learners and lower order thinking skills "discourages and limits the learner". Few students, he says, understand how to acquire knowledge by analytically thinking through the subject material. Lewis and Smith (1993: 136) agree that higher-order thinking "occurs when a person takes in new information along with information already stored in the memory and interrelates and/or rearranges and extends this information to achieve a purpose or find possible answers in perplexing situations." Retrieval of information is not always on a speed dial system where access is immediate. Retrieval of information may take some time to achieve. They go on to say that higher order thinking would include what to do or believe as posited by Ennis's definition (1989). However, lower order thought processes must be engaged first so that subject-specific knowledge can be developed, similar to that stated earlier by Eddins (2006). Lower order thinking in writing shows itself as being descriptive in nature and largely focusing

on content but with little correlation between concepts (Paul, 1990). Conversely, higher order thinking requires explanation through extended passages of text enabling the student to adequately reason their viewpoint on the required subject (Price, 2015). Higher-order thinking is therefore considered as productive thinking as opposed to lower order thinking which is thought of as reproductive thinking (Maier, 1933). Furthermore, Lemov (2010, in Thompson, 2011) believes that memorisation and learning of fundamental skills are crucial to critical thinking functions, where the more proficient one is at lower order skills, the more proficient you can become at higher order skills. The skills of critical thinking are higher order thinking skills (Maier, 1933; Beyer, 1985; Newman, 1990; Paul, 1990). There is clearly a difference between higher and lower order thinking skills, and the need to use the former depends on the nature of the task and the individual's inclination to use the skill (Lewis & Smith, 1993). Paul (1990) speaks about the logical/illogical dichotomy where higher-order critical thinking multiplies comprehension and insight, compared with lower order critical thinking which is perceived to multiply misunderstanding and prejudice.

In radiography practice, the action or outcome is directly linked to radiographers' knowledge and understanding of examination and of practice. Vygotsky (1962, in Kuhn, 1988) noted the observation of children's correct use of grammar, even before they became aware of this. The similarity here lies in the exploration of how student radiographers come to know that they possess those skills, i.e. in how they come to know that this is what they are doing and take control of the process of thinking. Kuhn (1988) maintains that conscious control of such skills is most significant in the development of scientific thinking. She elaborates that while non-conscious processes may help one's generation of ideas, one's ability to exercise control over one's thinking takes place through established "principles of inference" through a process of linking those ideas with evidence (Kuhn,1988: 7). For example, radiographers interpret radiographic images and are required to be critical and focused within a very specific context: diagnostic radiography. From the knowledge and comprehension levels of the taxonomy, a radiographer will then move onto analysis and evaluation of the radiographic image before making a comment or writing a report. In this way, the structure is not hierarchical as analysis and evaluation can be considered in parallel rather than in a hierarchy, as previously discussed. In my opinion, therefore, Bloom's taxonomy of the cognitive domain may work for theoretical university assessments, but not for practice-based courses or clinical placement assessments. In addition, the practical application of radiographic specific skills requires the symphony of cognitive engagement (knowledge, comprehension), the spatial and affective awareness (understanding), psychomotor skill application (application) and the critically reflective ability (analysis, synthesis and evaluation) to make ethically sound (moral values) professional judgments in relation to examinations, diagnosis and treatment. This is where

analysis, evaluation, and synthesis come into a radiographers' role; this is the area that my students struggle with, i.e. developing the higher order thinking skills of Bloom's taxonomy.

2.6.1. Summary

In this section, Bloom's taxonomy of the cognitive domain was analysed, discussed and presented as a model of how thinking is perceived to develop in education. The SEEC level descriptors which are fundamentally Bloom's taxonomy are successfully used currently in the module and programme design. Bloom's contribution therefore to the meaning of critical thinking is the top order of the hierarchy of cognitive skills, which is identified as analysis, synthesis and evaluation. However, these skills are precisely the ones that students struggle with on the diagnostic radiography programme. I have included the taxonomy within this review because it is a hierarchical model, of not just critical thinking, but shows the differences in the levels of thinking from knowledge through to synthesis and evaluation. Research is divided as to whether Bloom intended the taxonomy to be an indication of learning in a hierarchical sense.

2.7. The skills and dispositions of critical thinking

The purpose of this section is to discuss the cognitive and affective skills and dispositions needed for critical thinking to take place. Ennis (1989, 1993), Halpern (1989, 1997), and Facione (1990, 2010) list a number of dispositions they believe are vital to the application of critical thinking skills. Critical thinking in diagnostic radiography involves both cognitive and affective skills. However, the scarcity of publications on the latter indicates that it has not been considered as an area of concern in education. Much research has gone into defining cognitive skills that are perceived to help in the development of critical thinking as seen in previous sections, however, less emphasis is placed on a person's "affective" ability to actualise those skills (McBride et al., 2002: 30). 'Affective' means expressing emotion or feeling, or causing emotion or feeling (Dictionary.com, 2018c).

2.7.1. The cognitive skills of critical thinking

In this section, I draw together the cognitive skills of critical thinking as described by the aforementioned authors. These are analysed below.

- Interpretation involves the identification of verbal and non-verbal cues; the ability to recognise problems and strengths; explain the problem in written material, for example, X-ray request cards; the ability to consider other points of view, for example,

senior radiographers; the ability to distinguish their own points of view from actual information at hand and which must be specific to the context of the examination or situation at hand.

- Analysis involves the identification of the reasons, opinions, and arguments at hand; it examines the variables and data for relationships, e.g. patient age in relation to pregnancy status; makes the differentiation between fact and opinion, and analyses the implications of alternative decisions, e.g. rebook an examination for a later date or suggest an alternate imaging examination.

- Evaluation involves reflection and analysis of the reasons and arguments; it also judges the credibility of sources of information and evaluates rationale to support conclusions.

- Judgment refers to data, information, and arguments using appropriate criteria, e.g. patient data, emotional and physical state of a patient, and an appraisal of the value of data material.

- Inference involves the recognition of the necessary elements to draw reasonable conclusions.

- Explanation involves the description of the reasoning process followed in reaching the conclusions; the justification of one's reasoning, and conclusions in terms of evidence.

- Self-regulation involves the continuous monitoring, reflection, and questioning of one's own thinking (metacognition) in relation to all the foregoing steps in the reasoning process.

Critical thinking involves the process of reflection (Dewey, 1933) and it would appear that both thought processes are not mutually exclusive. Metacognition or thinking about one's own thinking is an important aspect of the reflective nature of being a critical thinker as previously discussed. Due to the number of dispositions associated with their thought processes, critical thinkers view their thinking as a process rather than an outcome. It is likely therefore that a critical thinker may continually question his thought processes. This is because, as Brookfield (2000) explains, critical thinking is a not a static activity but rather a continual, evolving process. It is therefore important that student radiographers develop the skills of critical thinking as an evolving life-long learning habit so that they can support themselves to continue to develop professionally. Tantamount to developing cognitive skills is the development of affective skills and dispositions. These are discussed below.

2.7.2. The affective skills and dispositions of critical thinking

In this section, the affective skills and dispositions of critical thinking are presented. The dispositions take into account the affective aspects of a person's ability to act or behave in a

way conducive to effective critical thinking. Having reviewed the meaning of critical thinking suggested by the authors within my conceptual framework, the dispositions containing affective skills which are common to them are listed below.

- *Being open-minded* involves showing an appreciation for different views and having reflective scepticism whereby you consider alternative ways of doing things which can be constituted as lateral thinking (Brookfield, 2002), or consensus-seeking, as appropriate.

- *Being inquisitive* enough to ask questions, follow up premises and get clarity on complex matters. In addition, by being prudent in making or suspending judgment and not acting impulsively, acknowledging that good thinking is hard work that requires diligent persistence. Schoenfeld (1985, in Halpern, 1997) found that success rates among mathematics students varied with the level of persistence in that unsuccessful students believed that if a problem could not be solved in less than ten minutes, that they would not be able to solve it. By contrast, successful students persisted in working through the difficult problems.

- *Seek the truth and be courageous to ask questions* in order to obtain the best knowledge on the matter and being well-informed even if you do not use the information in your decision making.

- *Being analytical* by ensuring you weigh up reason with the evidence and are able to anticipate consequences.

- *Being systematic and having an organised manner* in how you think through problems at all levels of complexity, including willing to plan and persist at a complex task.

- *Have self-confidence* whereby you trust your own reasoning and the manner in which you interrogate an issue in order to create the best outcome.

- *Have a tendency towards moral sensitivity and moral behaviour* grounded in ethical expectations where one is honest and fair-minded in one's belief, bias or prejudices.

- *Have self-awareness to correct one's thoughts or actions through self-reflection* and being mindful through metacognition. Good thinkers acknowledge that mistakes do occur, but, instead of being defensive, they are willing to learn from their mistakes and demonstrate care and empathy for another's dignity and welfare.

- *Be flexible enough to seek alternate views* which involves being willing to consider new options by trying things in a new or different way rather than responding negatively to new ideas by demonstrating unwillingness. An open-minded person is willing to suspend judgment, gather more information, and attempt to clarify difficult issues. Halpern (1989) clarifies that this does not mean that all opinions are equally good or that judgment should take a backseat to openness. Consensus-seeking in

collaboration with other persons or groups in a work situation is commonplace and critical thinkers need to possess good communication skills in order to find ways to compromise and to achieve agreement. This is a very important step in converting thought to action.

These dispositions are crucial to the empathetic, safe and ethical practice of diagnostic radiography. In addition, the professional and regulatory bodies of the profession seek to ensure that practitioners are achieving these dispositions as a minimum standard for practice. It is essential therefore that radiography training includes not only the cognitive but also the affective skills and dispositions for critical thinking so that they are able to meet this important requirement and expectation of professional autonomous practice. In relation to the skills and dispositions previously presented, Bloom's taxonomy of the affective domain indicates how a person's behaviour is affected at different stages of their development, as depicted in Figure 2.
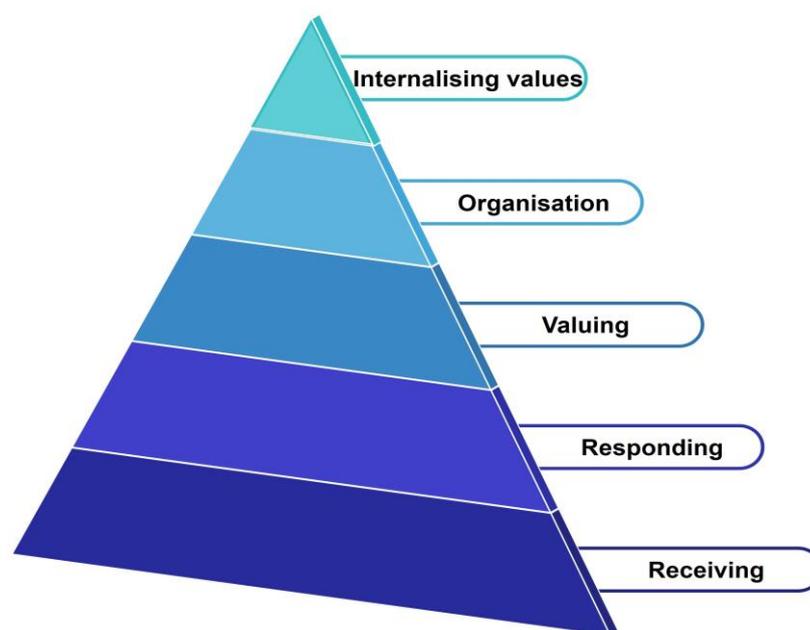
Figure 2. Bloom's taxonomy of the affective domain (adapted from Krathwohl et al., 1973)

There is a dearth of published work on the affective skills of critical thinking hence the use of Bloom's (1956) affective domain. I wanted to include this taxonomy to explore whether Bloom perceived the development of affective skills as a hierarchy similar to that of the cognitive domain. This domain relates to how we deal emotionally with daily encounters, for example, feelings, values, appreciation, motivations, and attitude. This is an area of particular

importance and relevance in diagnostic radiography due to the need for radiographers to have a balanced engagement of cognitive and affective skills. Too much or little of one could be counterproductive in their decision-making process, which can have consequences for their practice and patient outcomes. The behaviour as depicted in the hierarchy moves from a category of simple behaviour (bottom of the pyramid) to the category of the most complex behaviour (top of the pyramid). Each category is briefly described below. I consulted the work of Krathwohl et al. (1973) to aid the analysis of the taxonomy.

The taxonomy presents 'receiving phenomena' as its lowest dimension and relates to giving attention, being willing to hear, and having awareness of one's self. This skill can manifest by listening to others with respect and matches the disposition that Facione (1990) and Halpern (1989) speak off in relation to 'willingness to listen'. At its basic level, a radiographer may demonstrate this by acknowledging a patient's anxiety and demonstrate empathy in patient care.

The next category is called 'responding to phenomena' during which the expectation is active participation by learners where they are required to attend and react to a certain phenomenon by demonstrating a willingness or motivation to respond. Examples of this may be seen in active participation by students in group discussions or presentations, and in discussing new concepts or ideas. This closely matches the disposition of seeking the truth through courageously asking questions to obtain the best knowledge on the matter as mentioned by McPeck (1981), Ennis (1989), Halpern (1989) and Facione (1990).

The third category is called 'valuing' and is related to the value or worth that a person attaches to a particular object, phenomenon or behaviour. These are expressed through their behaviour and become identifiable as a person's personal attributes and moral and ethical attitude and behaviour. In radiography, this will typically manifest as a person showing understanding of cultural differences where diversity is valued. This skill predominantly relates to the disposition of being honest and fair-minded in one's belief, bias or prejudices as mentioned by both Halpern (1989) and Facione (1990).

The fourth category is called 'organisation' where the emphasis is placed on comparing and relating values according to what one would consider a priority value. Here there is a need for balance between one's freedom and responsible behaviour, where there is the expectation that professional ethical standards will be accepted. These are expressed through effective time management where the needs of the organisation, family and the person are met; as well engaging in systematic planning in solving problems. This directly relates to the professional

commitment of a student radiographer where behaviour and practice have to meet the expectation of the professional and regulatory bodies. Again, there are similarities between the description of this category with the affective skills and dispositions mentioned by Halpern (1989) and Facione (1990), viz. being systematic and having an organised manner to think through problems, willing to plan and persist at a complex task, and having a tendency towards moral sensitivity and behaviour.

The fifth category is called 'internalising values' and involves having behaviour that is consistent, predictable and characteristic of the student. These manifest by a student's ability to demonstrate self-reliance when working independently, using an objective approach when problem-solving, being committed to professional and ethical practice, revising judgment and decisions in light of new information, and in valuing people in a non-judgmental way. This will apply to student radiographers at Level six where they are expected to perform at a high level of decision-making in their justification of complex radiographic examinations and in prioritising the order in which those patients are examined. This category resonates with Ennis (1989) when he says that one should give due regard to the welfare and dignity of others, as well as having the ability to withhold judgment until the clear evidence is available, rather than acting impulsively. Lastly, demonstrating self-reliance, when problem-solving, is similar to Halpern's (1989) and Facione's (1990) disposition of having self-confidence and self-awareness. Thinking can thus be self-correcting through self-reflection.

The taxonomy of the affective domain is indeed a true hierarchy from simple behaviour to complex behaviour and presents how feelings and attitudes grow from one stage to the next. This structure is linked to the cognitive domain where there exists a lower and higher level of thinking. In their learning, students are expected to first grasp the lower level expectation in order to move to the higher level. In diagnostic radiography practice, it can be related to a student's development from achieving the lower level requirements, then moving past that stage to the higher-level requirements. In my experience, however, students can be performing at a lower level in relation to the cognitive domain, but at a higher level in relation to the affective domain. They may not achieve 'good grades' in their academic study yet they excel in the clinical placement environment. What is interesting within this domain is the role of a learner's motivation to move from one stage to the next. Thus, critical thinking skills application is dependent on a person's inclination to use their skills, the extent of which is demonstrated by the structure of the affective domain.

2.7.3. Summary of the cognitive and affective skills and dispositions of critical thinking

In this section, the cognitive and affective skills of critical thinking are presented. Having this structure presented as a hierarchy lends one to believe that the steps are hierarchical with the lowest being the simplest application of skills acting as the foundation for and leading to the development of the more complex higher layers of skills. Certainly, what is emerging from the description above is that as affective skills graduate from simple to complex they appear to align with the higher order thinking skills of the cognitive domain, i.e. in relation to the expectation of problem-solving, decision-making and judgment, seen in the higher levels of the affective domain. This gives the impression that in order to make objective, morally sound decisions (the higher order of the affective domain) one needs to have a good foundation of learning in relation to receiving and responding to phenomena, the lower order of the affective domain, similar to the development of the cognitive domain. The application of critical thinking skills depends on the person's disposition towards using their skills.

The role of pedagogy in the development of critical thinking is discussed next.

2.8. The role of pedagogy in developing critical thinking skills

In this section, the role of pedagogy in developing critical thinking skills is briefly discussed. Dewey (1916, in Kuhn, 1999) taught us that the goal of education was 'growth'. He elaborated that education was a necessity to foster the conditions that enabled growth; one that propelled a child towards a range of situations with varying complexity where they could capably apply reasoned inquiry. The role of pedagogy in the development of critical thinking skills, therefore, cannot be overestimated. Furthermore, the role of a tutor according to Dewey (1974, in Leshkovska & Spaseva, 2016) is indispensable in students' development by connecting the learning of the subject matter with their experience. The educator's task, he postulated, was to connect with this inquiry in a way that transformed casual curiosity into thorough inquiry and understanding. Although Dewey meant this in relation to the education of children, the principle of education and the role of a tutor remain fundamentally the same. However, a tutor has and currently remains the facilitator of learning, and not the provider of learning. This reaffirms that learning is always in the hands of a student, whether in the early 1900s or in present times. A tutor, therefore, is not the one who imposes the discipline of learning, it is derived from the student motivations themselves (Dewey, 1974, in Leshkovska & Spaseva, 2016).

Higher education today embraces an independent learning culture. Autonomy is linked to student-centered learning and therefore has a great role to play in education (Elekaei et al., 2016). Critical thinking fosters learner autonomy which should be prevalent in an independent

student-centered learning environment. The authors define learner autonomy as "attitudes of learners towards learning through which learners practice to take responsibility for learning" (Elekaei et al., 2016: 40). It involves both learning in a general sense and also about finding for oneself new ways of learning, e.g. self-directed learning especially at times when a tutor is unavailable to guide students. Thanasoulos (2000, in Elekaei et al., 2016) points out that development of autonomous learning is dependent on certain factors such as a student's motivation, attitude to learning and learning style. These authors further state that tutors assume that student attendance at lectures, and in-class participation, are sufficient to develop their critical thinking skills. Elekaei et al. (2016) reported results of studies conducted by various authors which revealed that students, with higher degrees of autonomy, were more motivated to learn. Findings also revealed that there was a significant positive relationship between self-directed learning and the critical thinking ability of students; and a positive relationship between critical thinking and autonomy of students. If this can be attributed to radiography training and practice, it can be assumed that autonomous learners should make autonomous practitioners. There therefore needs to be greater facilitation of learning from tutors and greater motivation to engage and develop their learning from students. Tutors need to ensure that their pedagogical practices enable this facilitation of learning in a positive manner, rather than feed the expectation of information giving.

Paul (2011) argues that although the development of critical thinking skills cannot be overestimated, there is a debate over the most effective pedagogical practices needed to achieve this development. He remains unconvinced that stand-alone courses, which profess to offer critical thinking skills training, actually produce the desired result of developing critical thinking abilities in students. In fact, he supports Gardner's (1993) theory in which people cannot transfer skills in one context to another due to the presence of their multiple intelligences. Gardner (1993) believed that learning from one domain or subject does not necessarily transfer to other domains, or subjects, due to the different types of intelligence that we possess. This may result in information being processed in a way that does not allow for the transfer of learning from one thought process to the other. Gardner (1983) explained that in a mixed audience classroom there are students who present with a range of learning styles. He feels that tutors must teach in a way that enables students to learn according to their multiple intelligences and doing so results in an increase of their comprehension in the classroom. In most cases, he says, tutors teach according to their own strengths which does not address the various learning styles in the classroom. In agreement with Paul (2011), Zobisch et al. (2015) posit that tutors may not be using the best methods to teach adult learners to think critically. Their study involving college students revealed that students on their course improved their mathematics learning and test scores by learning through a

multiple intelligences method of learning. Our pedagogical practices, as tutors, are therefore of paramount importance. These are revisited in Chapter Seven.

2.8.1. Summary

In this section, the role of pedagogy in the development of critical thinking skills was briefly discussed. Students' learning and development are dependent on their motivation and engagement which influences their autonomy as learners. The role of a tutor is instrumental in influencing student learning, especially in relation to the use of appropriate pedagogical activities in their learning and teaching practice.

2.9. Chapter summary

This chapter has provided an account of the literature search strategy used. A rationale for using nursing literature was provided. In addition, an analysis of the definitions from six prominent authors in the field of critical thinking was presented. The conceptual framework for the study was derived from comparisons made and the inclusion of discipline-specific requirements for critical thinking application in diagnostic radiography practice. The chapter developed to present the skills and dispositions required in the development of critical thinking using Bloom's taxonomy of both the cognitive and affective domains, and the dispositions of Halpern (1989) and Facione (1990), as the framework for this section.

Although the origins of critical thinking date far back into history, it is still contended today. There are a multiplicity of published definitions, from a range of disciplines, on critical thinking. The seminal authors emerged from the domains of philosophy, cognitive psychology and education. Some scholars couched their definitions within all three of these disciplines, e.g. Dewey (1909), and later Ennis (1989). It is clear that critical thinking involves the use of cognitive skills. One of the constraints of the philosophical tradition is that too much emphasis is placed on the requirements for logical thought and measurement of competence rather than performance. The psychological tradition of critical thinking has been concerned with understanding the nature of critical thinking and characterising critical thinking as it is performed taking into account the limitations that exist both within a person and the influence of the environment. The educational tradition lacks the epistemological underpinning that is characteristic of both the philosophical and psychological traditions which make it difficult to evaluate.

Critical thinking is domain specific and must be developed in relation to the context in which it is required to be applied. In diagnostic radiography, the use of both cognitive and affective skills and dispositions of critical thinking is required in order to practice safely and caringly. As tutors we need to consider our pedagogical practices in light of the methods required to develop the component skills required for critical thinking skills development in radiography.

Having presented a critical review of the related literature the methodological considerations and research methods employed in the study are presented in the next chapter.

Chapter Three

Methodological considerations and research method

3.1. Introduction

In this chapter, the methodology underpinning my study and the research methods employed in the conduct of the study, are presented. The chapter begins with a description of the ontological and epistemological positions which I took and how they informed the methodological design of the study. I then discuss the semi-structured interview approach as the source of data collection. Thereafter the main criteria for establishing trustworthiness in qualitative research are considered with an explanation of the strategies used to meet these criteria. The chapter then follows with a detailed description of the method employed giving due consideration of relevant and important ethical issues, and, an outline of the procedure followed in the collection, analysis, and interpretation of interview data.

3.2. Epistemology, ontology, and methodology

Ontology and epistemology are considered as the foundation of research work which informs the research questions and underpins the core assumptions that I have made about my investigation (Grix, 2004). Ontology is the nature of reality and a particular view of reality (Holden & Lynch, 2004). By the very nature of existence, there are different versions in the way nature is perceived. In order to consider the nature of reality that is sought in this study, I need to refer to my research questions, which are as follows:

1. What is radiography students' and tutors' understanding of what is meant by the term 'critical thinking'?

2. How do radiography students and tutors perceive the development of this skill through a programme of study?

3. What are the pedagogical implications for teaching and learning on the radiography programme?

The nature of my study lies in exploring the perceptions of critical thinking in diagnostic radiography education, and in how this skill develops through a programme of study at a university, where I am a principal lecturer. The social entities comprise people's views regarding their understanding of critical thinking and in exploring whether their views and thinking changes in a developmental way over time. My ontological stance about critical thinking is that because there are multiple views or perspectives of what people attribute to the meaning of critical thinking, it is not a clearly defined or commonly shared understanding

by either students or tutors at university, and as is also illustrated in the literature. In the field of diagnostic radiography, this becomes particularly important because, for a radiographer, critical thinking involves questioning a doctor's or referrer's request for an X-ray examination and justifying one's position to people who have more authority within the clinical setting, and this requires higher order thinking. The dilemma here is that if it is not well understood, how can students and tutors know what it is and what is expected in terms of its development and application in everyday decisions and assessment? Some of the participants in my study are students who are in training to be radiographers. They may not be confident to challenge or question authority, for example, and therefore are not critical thinkers. However, it is important for them to become critical thinkers because of the profession and practice, as detailed in Chapter One. As they go through the period of study their views on the meaning of critical thinking may change. These changes are of interest to my research.

In relation to tutors, they are responsible for teaching and facilitating learning in the students (Biggs, 2003). However, there is an assumption within HE that tutors understand what critical thinking means. Whether academics know the meaning of critical thinking and how they perceive this skill to develop remains to be explored as one of the main aims of my study, the findings from which are central and may have implications for education and training in diagnostic radiography. The kind of knowledge I seek to explore, therefore, is the participants' thoughts, views, attitudes, assumptions and understanding of critical thinking and how these may have changed through time, including the reasons for the change. Furthermore, I seek to explore the participants' views on how critical thinking develops through a programme of study. The nature of my study, therefore, is the building up of a picture of the meaning participants have attributed to the concept of critical thinking and their perception of its development over time. The study cohort began their training on the diagnostic radiography programme in September 2013 and graduated in July 2016. There were approximately one hundred and twenty students in this cohort; the study sample comprised thirteen student participants.

Mason (2002) describes epistemology as the theory or nature of knowledge and says that consideration of this should include how knowledge can be demonstrated or known. In addition, she says that epistemological inquiry should be based on what is it that we know, why we know and what are the limits of the knowledge? Furthermore, Grix (2004: 63) adds that epistemology is concerned with the knowledge gathering process "especially with regards to its methods." In relation to Mason (2002) and Grix (2004) above, and in answering the research questions, the theory or nature of knowledge that the study seeks lies in the exploration and interpretation of participants' responses from their experiences of learning and teaching on the radiography programme.

The development of students' learning over a period of time can be likened to the construction of new knowledge based on individual interpretations of reality. It involves descriptions of how a learner constructs or builds knowledge from past experience. The theory that underpins the construction of new knowledge from previous learning and experience is called constructivism (Bruner, 1960; Vygotsky, 1978; Piaget, 1985). Constructivism is an epistemological belief about what knowing is, how it is constructed via interaction with the specific knowledge and social interaction as well as *how* we come to know about something (Fosnot, 1996). According to Perkins (1992), the main views on constructivism have been offered from the socio-historical psychological perspective as seen by Vygotsky (1978), and from the field of cognitive science. The theorists here believe in individual interpretations of reality whereby the knower and the known are interactive and inseparable. The theories of knowledge and learning they present are discussed briefly in the following paragraphs.

Piaget's (1985) idea is that knowledge is formed from successive constructions and not solely from the experience of interacting with objects. He believed that cognitive development is cumulative whereby a new experience grows out of a previous learning experience. His work demonstrated his belief that children think in considerably different ways from adults and that their development occurs in four distinct stages. Children will experience each of these stages through their growth from a child to an adult (Piaget, 1985).

Vygotsky's (1978) theory focused on the dialectic between an individual and society, and the effect of social interaction, language, and culture on learning, i.e. internalisation and externalisation whereby the transition from external operation to internal development leads to qualitative changes. He believes that learning is a continuous movement from one level to the next higher level which more closely approximates a learner's potential. This movement occurs in what he calls the "zone of proximal development" as a result of social interaction. According to Ardichvili (2001, in Palmer, 2001:35), Vygotsky defined the zone of proximal development as the "distance between a child's actual independent developmental level in relation to the problem-solving skills and their level of potential development derived through problem-solving under supervision or guidance of an adult or peer." In this way, Vygotsky professed that learning occurred through the scaffolded support of adults, which in the case of the children were their parents or teachers. Scaffolding of learning has been mentioned by authors, for example Woods et al. (1976), and is a term well used to describe the development of learning from one stage to another in literature today. From my reading, however, it is clear that both concepts, i.e. 'scaffolding' and 'zone of proximal development' are sometimes used interchangeably in the literature.

Similar to Vygotsky, in Bruner's (1986) theory, knowledge is an active process; construction of new ideas or knowledge is based on current and past knowledge. Learners select information and make decisions in the process of integrating experiences into their existing mental constructs, known as discovery learning (Bruner, 1961). Children build knowledge hence the constructivist approach. He introduced the idea of a spiral curriculum where complex learning is presented in a simplified way first and when the child grasps this, the child then moves onto more complex levels of learning. In this way children are taught through increasing levels of difficulty which teaches them to problem-solve independently (Bruner, 1960). Learning occurs with the scaffolded support of more learned members of society, as mentioned previously. During the process of 'scaffolding', an individual is prompted to move past current levels of performance following external support and develop new abilities as they construct knowledge (Woods et al., 1976). The concept of scaffolding and the zone of proximal development fit closely with the learning experiences of radiography students where they learn and develop through the social interaction and guidance from university tutors and clinical placement mentors.

The constructivist theories formulated by Bruner (1960), Vygotsky (1978) and Piaget (1985) are concerned with knowledge generation and how learning is constructed, as discussed above. My study aims to gather a deep understanding of the lived experience of my participants. Research exploring the "lived experience, interaction, and language of human beings" is known as qualitative research (Holloway & Wheeler, 2010: 10). The theory of knowledge of my study, therefore, lies in the interpretation and description of my participants' lived experiences and in how they constructed new knowledge over time. Having discussed my epistemological position, my methodological position is discussed below.

Methodology refers to the theoretical principles on which research methods are based (Holloway & Wheeler, 2010). There are two main research principles or paradigms that govern research studies, viz., the quantitative or positivist paradigm, and the qualitative or interpretive paradigm (Fossey et al., 2002). In qualitative research, the basis lies in the "interpretive approach" of the social reality of human beings (Holloway & Wheeler, 2010: 3), and is a broad term for research methodologies that describe and explain peoples' experiences, behaviours and social contexts (Strauss & Corbin, 1990). Conversely, these authors posit that the quantitative paradigm is a scientific method (Mack, 2010) that deals with experiments in the empirical world (Strauss & Corbin, 1990). As the methodology of my study explores perceptions of critical thinking based on participants' experiences, I am, as a researcher, describing, analysing and interpreting their responses in order to answer my research

questions. My study, therefore, is positioned within the interpretive or qualitative methodological framework.

Qualitative research allows for the generation of context-rich data from participants' personal experiences. Denzin and Lincoln (2008: 9) assert that interpretations made in qualitative research draw on the popular traditions of ethnomethodology, grounded theory, and phenomenology whereby "no method or practice can be privileged over the other." However, each way of interpreting the data yields a different world view; they therefore say that researchers are often committed to using more than one interpretative practice in their study. Phenomenology, for example, supports the view that the world can be seen differently, by different people at different points in time, and therefore "celebrates" the idea of multiple realities, where each experience is "valid" in its own right (Denscombe, 2005: 100). Interestingly this is likened to the analytic approach of my study, which involves the exploration and interpretation of multiple participants' views or realities at different points in time. The study shares the qualitative approach of phenomenology with the constructivist forms of understanding, and therefore does not strictly fit a prescribed qualitative research theory, although there exists what Silverman calls "family resemblance" in the analytic approaches of both the traditions mentioned above (Silverman, 2011: 276). In this way, I can be considered to be what Denzin and Lincoln (2008: 4-6) call an "interpretive bricoleur" who uses "interconnected interpretive practices" to get a better understanding of the topic being studied.

3.2.1. Summary

In the above section, my ontological, epistemological and methodological positions were presented. My research questions sit firmly within my ontological and epistemological position, in that the nature of the 'beast' lies in exploring the meaning and development of critical thinking. Seeing the world through the participants' lens will give an insight into their reality, which I will use to answer my research questions and make interpretations that can be applied to radiography training and education.

3.3. Data collection method

This section describes and justifies the semi-structured interview as the chosen data collection tool of the study.

Face-to-face interviews were chosen on the basis of their ability to thematically explore a research topic with participants thereby acting as a method of generating rich data (Seale,

1999; Robson, 2011). Semi-structured interview formats use open-ended questions to allow an interviewer to get a better opportunity to explore participants' attitudes, opinions and perspectives in a deeper manner (Robson, 2011) which yields more meaningful information from insights gained (Silverman, 2011). This directly contrasts with the structured interview format which is prescriptive with respect to answering questions in a closed manner (Robson, 2011). The semi-structured interviews used in this study involved a set of agendas, or primers to prompt discussion of the research area, but also ensured that the list of topics on the guide was covered during the course of the interview. The structure allowed for flexibility in the order in which the topics were discussed and provided an opportunity for participants to elaborate their views and speak more freely. In addition, it allowed for unplanned questions to be asked. This structure, therefore, enabled a better flow of conversation with a discussion of the key aspects of the study topic that could not have been achieved had the interview been designed in a structured or unstructured format, for example (Robson, 2011). People attribute different meanings to their experiences of using critical thinking in their thought processes. The method of gathering such meaningful data has to be suitable to capture the richness and depth of insights that is required (Denzin & Lincoln, 2008), especially in relation to radiographic practice. This can only be gained, in my view, by using qualitative methods of inquiry. This was thus the reason for choosing to conduct a study using semi-structured interviews. From the literature searches conducted, there were no studies into critical thinking development within the published domain that were conducted using face-to-face interviews. Gloudemans (2013: 25), for example, alludes to studies that may be conducted using "anecdotal reports, reflective assignments, and portfolios" but there is no mention of using interviews as an exploratory data collection tool.

Apart from face-to-face interviews offering the advantage of being able to follow up interesting or conflicting responses, they provide personal contact (Robson, 2011). This is an important factor in making participants feel comfortable. It also enables an interviewer to pick up on non-verbal cues which may give bigger meaning to the responses received. However, Silverman (2011) warns that the lack of standardisation in conducting interviews is often criticised in terms of reliability. The skills of an interviewer are very important here in ensuring that an interview process is well conducted according to good research standards and practice (Seale, 1999). This was an essential consideration in my study. I was committed to ensuring that my approach was consistent for all student participants and all tutor participants. To help standardise my approach, I devised an interview schedule and followed this as a good practice guide, while allowing the necessary amount of flexibility to be able to explore comments further. Although the benefit of conducting face-to-face interviews has been explained, it must be acknowledged that one of the major disadvantages of conducting interviews is that they

are time-consuming (Robson, 2011). As the researcher I experienced first-hand the time-consuming nature of conducting an interview, however, I found it an incredibly rewarding process.

3.3.1. Summary

In this section, the semi-structured interview as the chosen data collection tool was described and justified. The next section presents a discussion of the criteria used to assure trustworthiness in the research process, and the actions taken to meet its requirements.

3.4. Demonstrating trustworthiness in the research process and findings

Lincoln and Guba (1985) advise that the quality of a research report lies in a researcher's ability to convince a reader of its trustworthiness or validity and reliability. This section therefore critically examines the measures I have taken to ensure that the process followed, throughout both the conduct of my study and analysis of data, were rigorous.

The terms 'validity' and 'reliability' are criteria which stem from quantitative research approaches wherein there is an expectation that results will be measurable and applicable to the wider population. The same expectation is applied to qualitative research where similar scrutiny deems the research trustworthy (Koch & Harrington, 1998). Lincoln and Guba (1985), *inter alia* recognise that findings of exploratory qualitative studies similar to this cannot be accurately measured as expected in quantitative research. This is, in fact, a key issue for all qualitative researchers, thus transferable criteria, similar to those used in quantitative research, have been suggested by these authors through which qualitative researchers can assess trustworthiness in their studies. The strategies I followed within the research process have been partially integrated into the discussion of how I met the criteria below but are discussed in detail as part of the research method in Section 3.6, p. 64.

Credibility refers to satisfying a criterion for establishing confidence in the validity or believability of the data by accurately recording the phenomena under study (Shenton, 2004), and by ensuring that findings reflect participants' realities (Merriam, 1998). The strategy used in this study to meet this criterion was member checking and respondent validation. Member checking involved inviting participants to read through their transcripts and agreeing on the accuracy with which the interview was transcribed as advised by Silverman (2011). Participants were also invited to verify emergent themes during the process of conducting the interviews (see Section 3.7), known as respondent validation (Silverman, 2011); a strategy

recommended by Miles and Huberman (1994). Getting participants involved in member checking and respondent validation in this way has been a valid method and considered by Lincoln and Guba as the "most crucial technique for establishing credibility" in the research process (Lincoln & Guba, 1985: 314).

Transferability refers to the extent to which the findings of a study can be applied to other contexts or subjects (Merriam, 1998). Qualitative research is context sensitive and therefore not generalisable to the wider population. However, transferability can be achieved by providing a rich description of the setting studied thus giving a reader enough information to be able to make a judgment regarding the applicability to other settings (Mack, 2010). According to Denzin (1989), a rich description of a research process involves great detail in describing a research setting, participants, and accounts of experiences. Thus, this criterion was achieved by providing a detailed contextual account of the research method as a rich description (see Section 3.5). Lincoln and Guba (1985) call this a 'thick' description, and similar to Mack (2010), feel that readers should draw their own conclusions regarding the transferability of findings.

Dependability, according to Shenton (2004), refers to the extent to which a study can be reliable in terms of its reproducibility. However, he goes on to say that due to the changing nature of the phenomena experienced by participants, receiving the same set of results is problematic. This could have posed a dilemma for the achievement of 'dependability', if Shenton (2004) did not thereafter clarify that dependability, similar to transferability, can be achieved directly by reporting the processes followed in sufficient detail to enable future researchers to repeat the study even though they would not necessarily get the same result. With regard to meeting this criterion, I provided a detailed account of the research design and its implementation as mentioned in the paragraph above. Silverman (2011: 360) agrees with Shenton that a research process must be "transparent" with regard to the process and data analysis methods used. Additionally, according to Seale (1999), dependability can be achieved through a process of auditing and creating a log of information. In order to capture my understanding of the evolving nature of my data, I decided to keep a research diary. Here I recorded my thoughts at various points during the research process. One example from my research diary is given below:

> *…during the pilot interviews, I listened to participants talk about their understanding of critical thinking. One of the students had studied a critical thinking module at A-Level. It was clear that they had some tacit knowledge of critical thinking, but they were unable to verbalise it. I had to pick it out of them in a way that directed their thought processes.* (AR, December 2013)

In relation to this, and throughout the research period I practiced reflectivity and reflexivity by maintaining continuous appraisal of the effectiveness of the process I followed, and by recording changes I made (see Chapter Eight). One such change is in the amendment of the interview schedule I used. This was pre-tested during the pilot study which was conducted prior to the commencement of the main study and is discussed in Section 3.6.1, p. 64.

Lastly, confirmability, according to Lincoln and Guba (1985: 44), refers to researcher objectivity or the degree to which the findings of a study are determined by subject responses rather than by the "biases, motivations, interests or perspectives of the inquirer." In relation to this criterion, a log of metacognitive and reflexive thoughts was kept during the research process, as mentioned in the paragraph above. See Section 4.4.1, p. 100 for a detailed description of metacognition and reflexivity. Being reflexive helped maintain awareness of my biases, especially during conducting of the interviews, as discussed in Chapter Eight. Reflexivity is considered by McCabe and Holmes as a "concept of qualitative validity" and auditing is considered to be a reflexive exercise (2009: 1519). Records of email correspondence, member checking of interview transcripts, and emergent themes, were therefore additionally recorded as part of the audit trail of my research journey. In addition, sharing initial findings with peers on the Doctor of Education programme (EdD), colleagues, tutors, and supervisors, and getting their opinion on my interpretation was helpful in confirming my understanding of the data. Furthermore, in relation to researcher objectivity, Miles and Huberman (1994) advise researchers of the need to present balanced views of arguments rather than those views which favour a researcher's position within the research. As a researcher, I have previous experience of conducting interviews since I did collect data using this method for my master's degree. This experience became particularly helpful during specific moments during the interviews when seemingly critical comments were made. I had to ensure, in those moments, that I listened carefully as a researcher and not as tutor or colleague (see Chapter Eight). The interpretation of my findings is therefore based on the responses and views expressed by participants and presented in an objective or unbiased manner, a detailed account of which can be found in Chapters Four and Five.

3.4.1. Summary

In this section, I have critically examined the criteria of credibility, transferability, dependability, and confirmability, and briefly described the specific strategies I employed to meet them. The next section focuses on the research methods used in this study.

3.5. Research method

A research project needs to begin with a plan, or blueprint as Yin (1994) calls it, which serves as a justifiable guide to answering the research questions. Having considered the philosophy and methodology that informs my research study, the purpose of this section is to present a detailed description of my research method and the procedure followed before, during and after the interviews were conducted. In addition, the progression of the interviews is discussed leading to the analysis and interpretation of the data.

3.5.1. Ethical considerations

This section presents a brief discussion on the ethical issues considered in the study. Cohen et al. (2007) and Creswell (2007) express the importance of researcher responsibility in conducting studies in an ethically sound manner. Studies involving human participants need formal approval by a recognised ethics committee who, in the process of scrutiny, ensure that the necessary ethical issues were considered with assurances that participants had not been put at risk of harm. Ethics approval to undertake the study was applied for and granted from the Social Sciences, Arts and Humanities Ethics Committee with Delegated Authority (See APPENDIX 3). Although Humphrey (2012) asserts that in research ethics, students do not constitute vulnerable populations and that choosing to participate in such a study is indispensable to professional pedagogy, the key areas of ethical concern were addressed to demonstrate that the recruitment and research process was conducted according to the expected ethical standard.

Prior to approaching students and tutors, permission was requested to access and recruit participants; this was granted by the Dean of School (See APPENDIX 4). The duration of the interviews was kept as short as necessary, i.e. each one lasted approximately an hour. Participants may have viewed the time required to attend the interview as an inconvenience. However, to overcome this ethical consideration the interviews were arranged at mutually convenient times. In relation to informed consent, all students were given a participant information sheet in advance of the interview date and time, in order to familiarise themselves with the participation requirements (See APPENDIX 5 and APPENDIX 6). At the time of the interview, I talked through the study requirements, asked the participants if they would like to clarify any information, or if they had any questions to ask, before inviting them to sign the consent form. Informed consent was provided by all participants (See APPENDIX 7 for an example of the consent form used in the study).

Participants were also informed that participation in the study was voluntary and that they could withdraw participation at any time without prejudice or coercion. They were provided with details of the research supervision team and ethics committee, should the need arise to contact them. They were also provided with details of the university counselling service should they feel the need to use this service. Pseudonyms were allocated to each participant thereby assuring their anonymity, and data collected was stored and handled securely and confidentially as per the ethics application protocol.

3.5.1.1. Summary

In this section the relevant ethical considerations were explained together with a description of the ethical approval process followed. The next section will present the sampling strategy used in the study.

3.5.2. Sampling

Qualitative research deals with gathering rich data, therefore the sampling strategy has to be focused on gathering appropriate sources of information (Fossey et al., 2002). Thirteen students, registered on Level four of the BSc (Hons) Diagnostic Radiography and Imaging programme in September 2013, were chosen to participate in this study. In addition, five radiography tutors were chosen to participate. The chosen sample had been selected on the basis of being 'appropriate' (Morse & Field, 2000), whereby they were considered as those having the information-rich data that I wished to explore in order to answer my research questions. The sampling technique used was purposive, convenience sampling which is one of the fifteen strategies suggested by Patton (1990, in Coyne, 1997). In addition, purposive sampling focuses on "relatively small samples" (Patton, 1990, in Coyne, 1997: 624). The sample size was considered pragmatic to achieve within the timeframe and appeared realistic when compared to studies conducted by fellow EdD colleagues. Purposive, convenience sampling, therefore, was the appropriate sampling technique used to recruit participants to my study and is considered as one of the strategies for assuring trustworthiness of data by enabling transferability of the research findings to the population from where the sample was derived, i.e. radiography students and tutors.

The strengths of the chosen sampling technique were that participants volunteered participation and made the commitment to participate in the relatively long-term nature of the study. However, perceived limitation of this sampling technique was the sample size, especially in relation to exploring the first research question. I considered using stratified

sampling to access a structured cross-section of the radiography student cohort for exploration of the first research question, 'what do radiography students' and tutors' understand by the term critical thinking?' However, after careful consideration, I decided that this was not achievable within the timeframe. Furthermore, exploring in-depth personal experiences does not necessarily warrant a large sample size. I followed the advice given by Fossey et al. (2002: 726) who stated that there is "no fixed minimum number of participants that are necessary to conduct sound qualitative research", however, sufficient depth of information must be gathered to enable the study of a phenomenon. The study, being of a longitudinal design, involved the same student participants in the interviews for three consecutive years. Fossey et al. (2002) assert that no sampling strategy is superior to the others; however, the trustworthiness of the findings is affected by the sampling choices made. The choice I made was therefore appropriate in relation to the quality of data I sought to gather in order to answer my research questions. Details of the recruitment and selection process are given in Section 3.6.2, p. 65.

3.5.2.1. Summary

In this section, the sampling strategy used in the study was presented and justified. A purposive, convenience sampling method was used to recruit thirteen students and five tutor participants to provide the context-rich data the study depended on. This sampling size was considered a pragmatic number of participants to work with in order to fulfill the aims of the study.

3.5.3. Demographic data of participants

The inclusion criteria defined student participants as being registered on the BSc (Hons) Diagnostic Radiography and Imaging Programme at a UK university, and tutor participants as being academic staff who teach on this programme. There were five male and eight female student participants (n=13). At the beginning of the study there were fourteen student participants, however, at the end of the first year, one student left the programme. In relation to tutors, there was one male and four female tutor participants (n=5). With regard to the age of student participants, five were considered to be mature students (over the age of 22 years) while eight were school leavers. Two of the mature student participants had previous educational qualifications at the graduate level. All five tutor participants had post-graduate qualifications in diagnostic radiography and in education, with between 5-19 years of experience of teaching at the university, and all but one were full-time teaching staff.

3.6. Procedure followed

3.6.1. Pilot study

This section outlines the changes made to the data collection tool following the conduct of a pilot study.

In order to ensure credibility and qualitative analogue of the study, a pilot study was conducted in advance of the first stage of the main study. Two radiography students, and two tutors, voluntarily participated in semi-structured, exploratory face-to-face interviews. The interviews were voice-recorded to enable transcription. The process of conducting the interviews was an interesting learning experience that prompted the following changes to the interview schedule for the main data collection of the study:

1. Revision of the interview schedule to make the interviews more flexible. These changes did not alter the aim of the research process.

2. Exploration of themes arising from the pilot interviews during the main interviews.

Following the pilot study, changes were made to the structure and sequence of the interview schedule (See APPENDIX 8 for the pilot interview schedule). For example, when students were asked towards the beginning of the interview, about critical thinking, they said that they did not know what it was. This made further exploration difficult as their minds appeared closed to the question. I, therefore, had to consider a different way to explore this and decided to explore their understanding of critical thinking towards the latter part of the interview. I rephrased some of the questions to aid clarity and ease of questioning. This improved the structure and flow of the interview schedule which enabled probing of responses while still allowing the overall remit of the interview to be explored. Participants were able to speak more about critical thinking towards the end of the interview as compared to the beginning of the interview. It is important to note that no new information was added to the interview schedule following the amendment mentioned before. The structure and sequence of the questions were the only changes made; the aim and objectives remained the same. The amendment did not require minor modifications following changes to the schedule so no further ethical approval was therefore required (See APPENDIX 9 for the first phase student interview schedule).

3.6.1.1. Summary

In this section, the changes made to the interview schedule following the pilot study were presented. By conducting the pilot study and following a process of reflection and reflexivity meaningful changes to the interview schedule were made for use in the main study. The next section presents the recruitment and interview process.

3.6.2. Participant recruitment, interview process, and progression

The study was designed as a longitudinal study in order to explore student participants' experience of their development of critical thinking over a period of time. In addition, I was exploring the progression of the students' development in their understanding of the meaning of critical thinking over time. Following permission from the Dean of School, and ethics approval, a letter of invitation and participant information sheet was emailed to all students enrolled in the first year of the radiography programme in September 2013. Students were given two weeks to respond to the email with a specific date and time deadline. Seventeen students emailed their expression of interest by the set deadline. Although the initial minimum number of participants I aimed to recruit was twelve, when I received seventeen expressions of interest, I was keen to recruit all seventeen in order to account for possible attrition over the research period. All seventeen students were therefore sent 'thank you' emails offering them interviews. Fifteen students responded to that email and interviews were scheduled with them. Of the fifteen students who responded, fourteen interviews were conducted. The three non-responders were followed up; they did not reply to emails thereafter and were not pursued further. Unfortunately, one of the fourteen students left the programme at the end of the 2013/2014 academic year. Consequently, the participant's transcript was removed from the study as there would be no continuity with respect to exploring development through the programme period. This yielded the final sample size of thirteen student participants. The student participants attended one semi-structured face-to-face interview at the beginning of their first, second and third year of study in accordance with the timeline presented in Table 1 below.

Table 1. The timescale for conducting the interviews

The first phase of student interviews	October 2013 – December 2013 for 14 interviews
The second phase of student interviews	October 2014 – November 2014 for 13 interviews
The third phase of student interviews	August 2015 – September 2015 for 13 interviews
Tutor interviews	March 2014 – July 2014 for 5 interviews

The aspect of the study involving tutor participants was designed as a cross-sectional survey of radiography tutors. The tutor participants' involvement in the study comprised one interview only. At the time of data collection, there were sixteen radiography tutors who taught on the

programme. All were invited to participate, however, only five tutors volunteered and were recruited to the study.

In planning and conducting the interviews I took cognisance of the power dimension which *will be* discussed in Chapter Eight and took reflexive measures to ensure that the participants felt free, comfortable and relaxed during the interviews. All interviews were scheduled at mutually suitable times. They were conducted remotely from my office whereby meeting rooms were booked for this purpose to ameliorate any feelings of discomfort, avoid interruptions and to demonstrate value in the interviewing process. Interviews with participants began with a light 'chat' about how they were getting on at university before moving on to the nature of the study. I thanked them for giving up their time to talk with me and assured them that there was no right or wrong response and that they were not being tested or judged. This was of particular importance due to the perceived power relations in research of this nature, where I am a tutor, programme leader, and colleague. More details on my reflexive positions are given in Chapter Eight, p. 179.

In addition, I thought about how student participants would feel during the interview, so I took care with my appearance where I opted for a more casual, relaxed look in denim jeans, rather than the more formal look I adopt when teaching or attending meetings. I also took bottled water to the interview room and took care in setting up the room, for example, in positioning the chairs in a way I thought the participants would feel comfortable. Participants were again given the participant information sheet to read and opportunities to ask questions. Thereafter they were invited to sign the consent form. I then explained the context of the interview and how that fitted into the entire study to be conducted over the three-year programme period. Interviews were then voice-recorded on a portable recording device to enable transcription thereafter. The interviews were then conducted using the schedule as an exploratory guide.

I did experience from the interviews conducted during the pilot study that participants would sometimes 'go off on a tangent' but nonetheless responded in a 'round-a-about' sort of way. When this happened, I needed to listen attentively throughout this time, as often at the end of that conversation stream, I found 'nuggets of gold', which were unexpected. It was important, therefore, for me to keep an open mind for surprising and unexpected information. It required skill and intuition to be able to decide whether to curtail a certain conversation or allow it to proceed in light of what could emerge as a result. In my experience, the skills required to become a good interviewer develops with the practice over time. During the interviews, I found it important to ask questions in an open-ended manner to enable participants to freely express their views. I also used probes and prompts as tools to get the interviewee to expand on a

response. I did this on a number of occasions when I felt that participants had more to say. Examples of common probes that were used were: 'can you tell me more about that?' or 'anything more?' as suggested by Robson (2011). He further advises that interviewers should avoid asking questions using the following style: long questions, multiple questions, complex questions using jargon, leading questions and biased questions (Robson, 2011: 282), which I was mindful of during conducting the interviews. See APPENDICES 10 and 11 for an example of a student and a tutor interview transcript respectively.

All interviews were conducted without problems and lasted approximately one hour. I thanked participants for their time and participation at the end of each interview. At the end of the interview, participants indicated that they enjoyed the 'chat' saying that it was very rare that they got a chance to speak about critical thinking. They offered their ongoing support if more time was required. They were very supportive of the study and saw this as a valuable contribution to the programme that could make a difference to student learning. Five examples of verbatim quotations from student participants are given below:

> *I really enjoyed it and I feel like I'm being useful and helpful. If there is anything else that is needed, let me know.* (Isla)

> *Nice room…at least we're not disturbed as your office is always busy.* (Lola)

> *Definitely enjoyable. I never thought about critical thinking in the way I did in these two years.* (Emily)

> *It is not something that anybody generally speaks about, so I really enjoyed the deeper questions that you have asked.* (Chloe)

> *You have asked a lot of searching questions and it has helped me to learn more about myself. Learning should be a life-long process.* (Jacob)

These data extracts exemplify the value of pedagogical research of this kind.

3.6.2.1. Summary
In this section the following was presented: the process followed in the recruitment of participants, the interview process, and progression of interviews. The next section describes how the interviews were undertaken over a period of time.

3.7. The interview stories
This section sets out the rationale for conducting the interviews in the longitudinal, chronological order I designed.

3.7.1. First phase student interviews

The first set of student interviews was conducted during October, November, and December of 2013 prior to students' attendance at clinical placement. The reason I conducted the interviews in this way was to get an understanding of where the students were with respect to answering my research questions at the beginning of their training (on the radiography programme). As first-year students who are new to study at university, my assumption was that they were new to critical thinking and that they would not really have thought about or have experience of critical thinking. In addition, they had not been out to clinical placement at that time and therefore could not understand how critical thinking skills could be applied or could impact on practice. The interview schedule was used as a guide to ensure that the topics that required exploration were discussed.

The first set of interviews were transcribed and sent back to the research participants to verify their accuracy, to ensure trustworthiness in the process as advised by Denzin and Lincoln (2008) and as discussed in Section 3.4, p. 58. All participants approved their transcripts as an accurate record; a few made minor edits and sent me their edited version. Those versions were saved and used in the study. As I read through the transcripts, I made notes of early trends in their responses. I explored these emerging ideas, in a natural way, during the interviews that followed. It was interesting to explore these ideas at this stage in order to validate them and add to the rigour with which the interview process was conducted especially in relation to the interpretation of data, as discussed in Section 3.4. A reflective insight from my research diary is given below:

> *It is evident that there is no encouragement to think critically in year one. This could be due to the fact that according to the skills development matrix as presented in the SEEC descriptors, critical thinking is not a Level four outcome. Students who were fresh out of school feel that they need more life experience to know what critical thinking is, while some say they know the theory but have not had sufficient practice in applying what they think they know. There is a general consensus that you need knowledge and experience to know what critical thinking is. I think this is a good starting point for the study.* (AR, December 2013)

Some of the early emergent ideas following the first phase interview were:

•   Consequences of taking quick decisions

•   The negative effect of decisions on patient outcomes

•   The link between 'good thinking' and self-confidence

•   Deep thinking versus superficial thinking

These were explored during the second interviews (see APPENDIX 12 for the second phase interview schedule).

3.7.2. Second phase student interviews

Prior to the second interview, students completed a range of teaching and learning activities and assessment at university, in addition to attending their first two blocks of clinical placement. The objectives for conducting the second phase interviews were as follows.

1. To determine whether students' understanding of critical thinking had changed since the previous interview?
2. To explore whether students' perceived ability to think critically had changed since the previous interview?
3. To explore the reasons for those changes (as appropriate)

In addition to the objectives given above, the student participants were asked to think of a factual scenario from their experience. During the first phase interviews, student participants related their experiences and understanding to specific scenarios very well, hence the inclusion of a scenario during the second phase interviews. They were taken through a series of questions using the information given in the schedule. The questions framing this scenario were based on Halpern's (1989) and Facione's (1990) description of skills for critical thinking. (See APPENDIX 12 for the second phase interview schedule).

Another reflective extract from my research diary from this stage of the interview process is given below:

> *I need to revisit the strong ideas that emerged from interview one during this next phase. I may find that that the comments yield a high level of discussion which might have to do with experience from clinical placement, for example, in terms of decision-making. They (students) may have some experience in terms of having to make a decision based on working with a patient. They already spoke a lot about having to make a decision following deep thinking. This may come through quite strongly, for example, if development is shown, this could be a substantive or major theme for my study. Then there is process versus product – Jon mentioned this in last week's supervision meeting and it came up in my reading as well. The process of their thinking in how they manage their thinking in the clinical setting. This leads to the decision – the product. Decision-making is the process and product of thinking.* (AR, October 2014)

Following these interviews, I once again transcribed the interviews and emailed them to each participant for verification of accuracy. All transcripts were verified as accurate records of the interview. I then compared the responses to look for any change in their understanding of critical thinking and reasons which influenced the change, if any. The responses from this interview, therefore, dealt with student participants developing understanding and awareness of critical thinking in the contexts of their own personal critical thinking development and in their clinical placement experience and learning respectively. I also looked for a change in the

complexity of the factual events they spoke about. Following the transcription of the second phase interviews, responses to some of the following themes were beginning to consolidate from those extracted during the first phase interviews. In this way, the second phase interviews validated the data from the first interview and received reassurance with regards to the trustworthiness of my interpretation of the initial data collected. The following themes were further explored during the third phase interviews:

- Role of clinical placement
- Linking theory to practice
- Change in attitude or perception
- Thinking about simple tasks versus complex tasks
- Role of feedback in encouraging and motivating learning
- Can all thinking be critical thinking?
- Can reflection be critical thinking?

Another diary entry following the second phase interviews is given below:

> *I am not surprised that students were so concerned with the moral and ethical side of the decision made in placement and outcome for the patient. This tells me that they have a strong understanding of the expectations placed on them by SCoR and HCPC and of course the patients themselves. It was heartening to listen to examples from their experience. I feel as though they've suddenly grown up. It has been about a year since the last interview and I am so pleased that they have learned so much during this time – both with my researcher and programme leader hats on. I know through working with the remainder of the class though that not all students in their cohort have developed so much…I liked the fact that some say they had become open-minded and did not like being spoon-fed information – from a tutor perspective this is very interesting as students always ask for more and more and I am not convinced that they use what we give them.* (AR, December 2014)

3.7.3. Third phase student interviews

Before the third phase interviews, students had experience of a much broader range of teaching and learning activities and assessment at university. In addition, they had attended longer periods of clinical placement which included elective placements and more advanced, specialist imaging placements. These interviews took place between September and October 2015 and were the final phase of data collection with student participants. It would have been ideal to have conducted this final set of interviews towards the end of their final year, especially to capture their critical thinking skills development from undertaking their research projects, however, due to scheduling constraints involving the programme year plan and student timetable, it was not pragmatic to do so. The interviews were therefore conducted at the

beginning of the students' final year of study resulting in an even space between the first, second and third interview phases.

The objectives of the third phase interviews were:

1. To explore and gain an update on students' understanding of critical thinking.

2. To explore their journey and gain an update on how they perceive their critical thinking skills to have developed and what factors influenced their development.

3. To perform a member check on emergent themes/ ideas from the second interview.

4. To explore a fit for purpose definition of critical thinking that can be applied to radiography education and practice.

The interview schedule for the third phase interviews can be found in APPENDIX 13. After the completion of this interview set, all interviews were transcribed and once again sent to participants for member checking and validation of accuracy. Participants again agreed on the transcripts as an accurate record of the interview. The responses from this interview built on their understanding of critical thinking in a much deeper clinical radiographic sense compared with the first and second-year interviews. A reflective diary entry from this stage of the interview process is given below:

> *When I reread their transcripts this week, what I was impressed about was the development in their understanding of reflection. Some* (students) *spoke of how their ability to make decisions was getting faster and faster, e.g. they were able to justify the X-ray request card more quickly over the year. Some showed awareness of how situational consequences can affect decision-making and resultant actions. This may have implications for decision-making, so I need to be aware of this when writing up the findings. Their learning has informed their own experience and resulted in more learning, perhaps a higher-level learning which is more abstract. This could lead to metacognition…perhaps. I need to think about this and speak with Di. Also, a point of discussion at our next supervision meeting - could a disposition of critical thinking be that it applies to new or complex situations only? When something has worked well in the past, you can repeat the action without the need to think critically about it. This constitutes mechanical thinking. Is this considered as scientific thinking? A point for further reading here...* (AR, March 2016)

3.7.4. Tutor interviews

Tutor interviews were conducted between March and July 2014 (See APPENDIX 14 for the Tutor participant interview schedule). Similar to the objectives explored with student participants above, these interviews explored tutors' views on the meaning of critical thinking, how they perceive this skill to develop and likely implications for pedagogy on the radiography programme. These interviews occurred as a once only occasion in order to gain a snapshot of their understanding of the study topic. Following these interviews, I transcribed the interviews and emailed them back to each tutor participant for verification of accuracy. A number of themes emerging from the student interviews were explored in the tutor interviews,

e.g. the role of clinical placement, theory to practice, feedback, and reflection. In addition, tutor participants verified their transcripts as accurate records of the interviews. A reflective extract from my research diary following the conduct of tutor interviews is given below:

> *I was nervous at the start of the interviews with fellow colleagues, but the process became more comfortable as the interviews proceeded. I did exercise mindfulness when asking the questions as I continually had to shift between the insider and outsider positions. This was tough, and I must write this feeling into my reflexivity. However, I share most of their comments and agree with the observations from their experience, especially in relation to constraints on our time and the student expectation. This I managed with my tutor hat on but as the researcher and programme leader I feel that there is a whole lot more we can explore in relation to developing pedagogy in a supportive way to build critical thinking skills in students.* (AR, August 2014)

3.7.4.5 Summary

In this section, the chronological positioning of the interviews was presented and justified. The next section will describe the data analysis process.

3.8. Data analysis

What separates qualitative research from its quantitative counterpart is its "special approach to data collection and data analysis" (Denscombe, 2005: 267). Qualitative data analysis is the process of "reviewing, synthesising and interpreting data" in order to explain the phenomena under study (Fossey et al., 2002: 728). Miles and Huberman (1994) advise that data analysis should include the evolving design of a study with transparency regarding the conduct of the interviews, analytic processes followed and how these informed the design of the study, hence the detailed description of the process followed given below. I began thinking about the data and analysing what my participants were telling me during the interviews themselves. The formal process of analysis began following the transcription of the first phase student interviews. By the end of the third phase student interviews, no new ideas emerged from the data. I therefore conceded at that point that data saturation had occurred. Although the process is described in a linear fashion, data analysis in itself was non-linear. There was continual recursive movement between the data, codes, and categories, such that my analysis and interpretation present my participants' perspectives authentically (Fossey et al., 2002). The following steps outline the process I followed in systematically and methodically analysing my data using guidance from Lincoln and Guba (1985), Ball (1991), Miles and Huberman (1994), Merriam (1998) and Denscombe (2005). The flowchart given in Figure 3 outlines the data analysis process I followed.
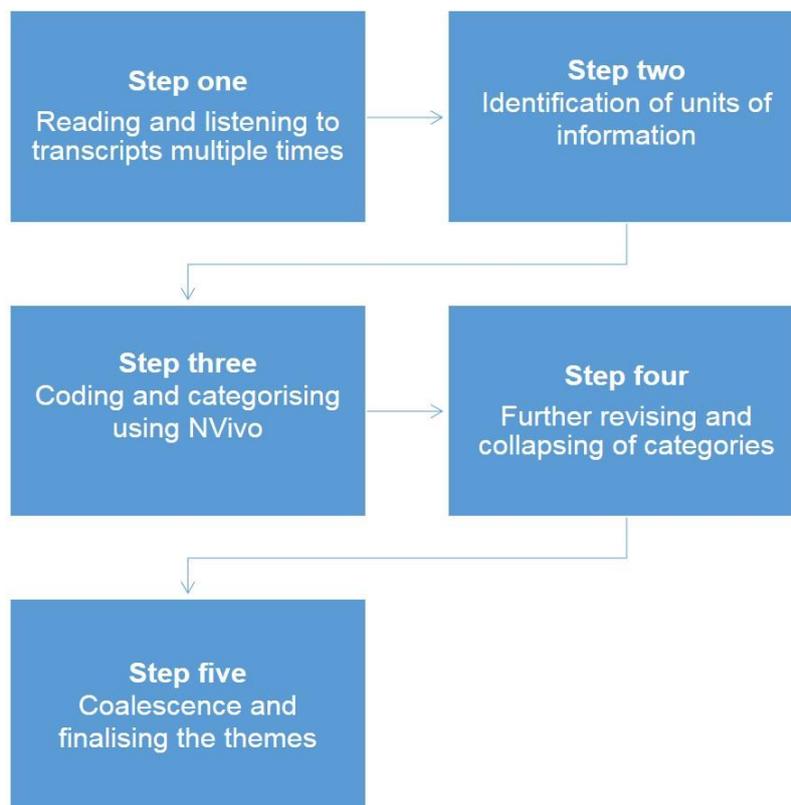
Figure 3. Flowchart of the data analysis process

3.8.1. Data analysis process

Step one

Transcribing the interviews allowed me to familiarise myself with the data, language and the nuances of the conversation that were not necessarily apparent on a typed transcript. Once transcripts were returned to me following participant verification, I anonymised the transcripts by allocating each one a pseudonym. I prepared all materials in the same format, e.g. using an A4 sized page in the landscape layout with a blank margin on the right side of each page. I read the transcripts many times, from beginning to end, as suggested by (Merriam, 1998), and jotted down my initial comments in the margin of the transcripts. I also used a highlighter pen to mark off "slices of data" as Ball (1991: 182) terms it. This usefully enabled me to record thoughts that stood out at this initial stage, which Merriam (1998) called, the organising, abstracting and integrating process. Most of my comments focused on labeling the data or recording a brief analytical summary. See APPENDIX 15 for a sample transcript page showing highlights and comments.

Step two

Once I had commented on all transcripts and had a good volume of labels and analytical comments I typed up all the comments that my reading and thinking generated. This demonstrated the common ideas emerging from the data at this early stage, which constituted, what Lincoln and Guba (1985: 344) call "units of information," see APPENDIX 16 for a list of the units of information.

Step three

Following this, I devised categories which best described the units of information. Each unit was then sorted into a category. If a comment did not fit a category I left it aside and at the end of the sorting process this category was called 'outliers.' In devising the categories, I took Guba and Lincoln's (1981) advice and sorted the units of data according to their suitability within the category, i.e. ensured that the categories were internally homogenous. I also ensured that where the categories were externally heterogenous, the differences between them were "bold and clear" (Guba & Lincoln, 1981: 93), for example 'pedagogy' and 'decision-making.' Devising the categories was a useful exercise as chunking of several bits of data helped me, as a researcher, to see an "initial plot of the terrain" (Miles & Huberman, 1994: 69). NVivo data analysis software was used at this stage. NVivo is a type of computer-aided qualitative data analysis software (CAQDAS) that is used to sort, organise and manage qualitative data. The transcripts firstly needed to be formatted, in rich text format to then be imported into NVivo. NVivo was only used during this initial part of the data analysis process. Although NVivo was useful for managing the data, coding the data, after hand coding, was a tremendously time-consuming process. See APPENDIX 17 for the NVivo code sheet demonstrating the various categories.

Step four

In the next step, I printed the codes/categories and the data contained within them from NVivo. I worked with the data sheets to further consolidate the categories and units of information. At this stage, I extracted certain ideas that were emerging strongly from the first student interview phase to explore within the second student interview phase, for example, 'deep thinking versus superficial thinking.'

I then completed and transcribed the second phase interviews. I began the coding process as described above in steps one and two. During this process, I extracted more units of information which were then added to the data already contained within the categories. Some new categories were emerging at this stage, e.g. learning at clinical placement and challenges in developing critical thinking skills. The categories were added to the list of categories and

suitable units of information were included therein. See APPENDIX 18 for a revised list of categories.

I then extracted certain ideas that were emerging strongly from the second interview data to explore within the third interview data phase, for example, the role of clinical placement learning, linking theory with practice, and the link between reflection and critical thinking. This served as a useful indicator for respondent verification of the emergent ideas that were beginning to consolidate as key findings.

I thereafter completed the tutor participant interviews and the third phase of the student interviews. Units of information from these transcripts were categorised. Following the completion of the tutor and third phase student interviews certain categories were beginning to consolidate, for example, the role of placement learning in critical thinking development, reflection, and challenges experienced. Gaining respondent verification of the strong emergent ideas derived from the transcripts was a useful exercise in establishing the trustworthiness of the findings and helped to cement my interpretation of the data. Also helpful in the interpretation of data was my logging of thoughts at various points during the analysis process. See examples of diary entries presented in Section 3.7, p. 67.

Step five

The categories from each interview phase were thereafter further revised and collapsed into more manageable chunks of data. See APPENDIX 19 which demonstrates the coalescence and evolution of the themes and subthemes from the first to the third student interview phases and tutor interviews, and APPENDIX 20 for the final themes of the study. The data analysis process was useful in developing what Silverman called a good, "working, hands-on empirical, tacit knowledge of the analysis" leading to the development of "a qualitative analytic attitude" (Silverman, 2011: 274). This helped to classify the themes into hierarchical higher and lower order components leading to the final themes of the study. Themes according to Ryan and Bernard (2003) are abstract concepts that are found before, during and after data collection. The two main themes of the study were the *meaning* of critical thinking and *development* of critical thinking. These themes represented what Goetz and LeCompte (1984: 36) called "concepts indicated by the data" and although "intuitive" in its nature it is also informed by the purpose of the study, "investigator's orientation and knowledge and participants of the study" (Goetz & LeCompte, 1984: 191). With the study data securely situated within the aforementioned main themes, this formed the basis for the writing up of the findings.

3.8.2. Interpretation of data

I then began the interpretation of the data by moving to what Miles and Huberman (1984) call a more theoretical or conceptual mode of thinking. I began making inferences based on my reading of the data by asking myself searching questions about what the data were telling me, trying to draw out the deeper meaning in the data, i.e. by going beyond the words of the data, from the "empirical trenches to a more conceptual overview of the landscape" (Miles & Huberman, 1984: 228). Speculation is the key to developing theory in qualitative research (Merriam, 1988). Conceptualising the data allowed me to speculate and make assumptions about the practice of my programme in light of the participants' experiences. It also enabled me to draw inferences about what shape further practice might take. During this process, I frequently thought about possible reasons that could be attributed to the participants' responses and their likely implication for both pedagogy and future practice, while being careful to ensure that those thoughts were being managed as a researcher and not as an insider. This was an important step in ensuring trustworthiness in the interpretation of data as recommended by Lincoln & Guba (1985).

From the data, it was clear that participants could not separate their understanding of the meaning of critical thinking from their understanding of how they developed critical thinking skills over the three-year period. The themes themselves are not mutually exclusive; their existence is clear yet complex especially in the relationships they share with each other. There is, therefore, some overlap within the discussion which may appear repetitive, between these themes. Handling the interview data was challenging and resulted in creative chaos as I sifted through the large volume of interview data by trying to draw out the ideas that were emerging and then consolidating, as students progressed from year one to year three. Engaging deeply with the data however clarified and sharpened my thinking in relation to the main themes of the study. My interpretation of the data presents a thick description of patterns and ideas emerging from the interviews with the presentation of student interview responses followed by tutor interview responses. Presenting the findings in this way was a useful way of demonstrating the evolution of the students' understanding of the meaning of critical thinking and their perception of how critical thinking developed throughout their three-year study period. I also developed a set of generalisations that explained the themes and relationships that had been identified in the data as advised by Denscombe (2005: 272). See APPENDIX 21 for a description of the themes.

Discussing the initial emergent themes with EdD colleagues during study days were useful in confirming my interpretation of the data. Also beneficial was my contribution to in-house, national and international conferences and seminars where my findings were presented to mixed audiences comprising diagnostic radiographers and other health, social work and allied health professionals in practice and academia. From this study, a collaborative project is in the process of being developed with colleagues from three countries. These platforms, therefore, were valuable opportunities to gather meaningful feedback that aided the data analysis and interpretation process.

3.9. Chapter summary

In this section, the research methodology and all aspects of the research methods used in this study have been presented. Qualitative research involves the generation of rich, deep, meaningful, contextual data which are descriptive of participants' opinions, perspectives, and experiences, and requires interpretation and understanding of those views. Qualitative research is judged by the alignment of the methodologies and methods used. Accordingly, I explained the methodological approach used in the design and conducting of the study and justified the framework within which the study is located. I described my ontological and epistemological position and aligned my methodology with the methods used. A number of strategies were used to assure the quality and rigour with which the study was conducted (methodological rigour) and data were analysed and interpreted (interpretive rigour). Thematic analysis was used in the data analysis process to extract the final themes emerging from the study. The principle approach in this study has been interpretative but has drawn upon the constructivist forms of understanding as theorised by Vygotsky and Bruner, in particular.

Having discussed the research methodology and methods employed in my study, the next chapter presents the findings in relation to participants' understanding of what is meant by critical thinking.

Chapter Four

Findings in relation to participants' understanding of what is meant by critical thinking

4.1. Introduction

In this chapter the findings in relation to my first research question, "what is radiography students' and tutors' respective understanding of what is meant by the term critical thinking?" are presented. First, the data from the student interview phases are presented followed by the tutor interviews. Changes in understanding were highlighted during the second and third phase student interviews. There were three subthemes which emerged from this theme and these are presented below. The subthemes closely match the meaning of critical thinking presented in my conceptual framework.

- Critical thinking as logical thinking involving the evaluation of information
- Critical thinking as the decision-making process
- Critical thinking as reflection and metacognition

Figure 4 presents the relationship between the subthemes.
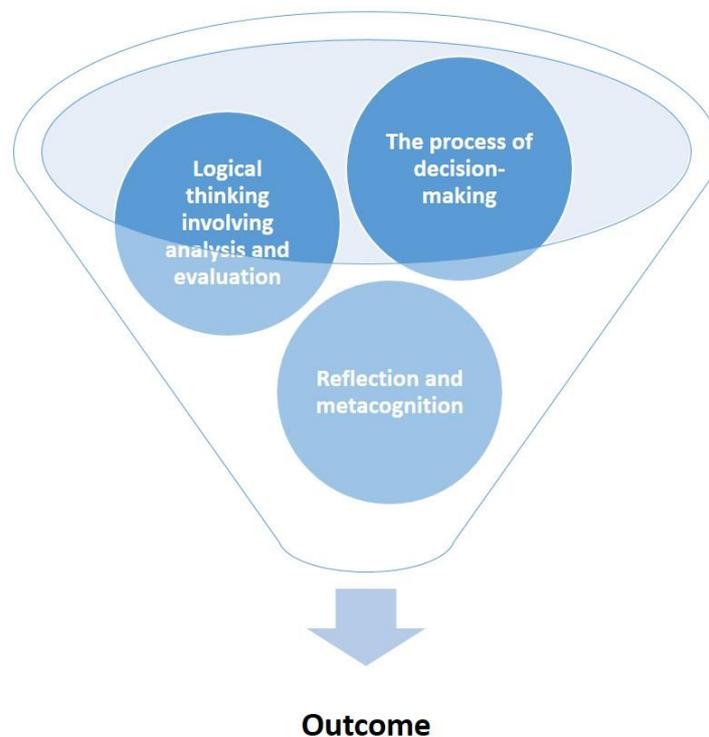
Figure 4. Visual illustration of the relationship between the subthemes in relation to the meaning of critical thinking.

Later in the discussion chapter I discuss how these subthemes interrelate and overlap.

4.2. Critical thinking as logical thinking involving the evaluation of information

This section focuses on findings in relation to the above-mentioned subtheme. Student interviews in year one began by talking about thinking and how information is perceived, and then developed into a discussion about decision-making, followed by critical thinking. Participants' verbatim responses are presented in italics.

4.2.1. Responses from the first phase student interviews

During the first phase interviews the students' views on how they handled information on a daily basis were explored. Their responses indicated that in the process of considering information, they did not generally believe everything they saw or heard due to the information being someone else's view which carried the potential for bias. They would, therefore, gather information that had been 'checked' or 'reviewed', implying peer-reviewed information, which they considered as 'objective' and therefore deemed as reliable as observed in the comments below:

> *I will question things quite a lot. I don't just accept what people say. People and sources such as the internet aren't always right, and their views may be biased whereas I prefer objective knowledge. I generally trust journal articles and books a lot more, as they have been checked or reviewed.* (Jack-IV1)

> *If I'm seeing something in the news or something in the paper, I am conscious that I'm seeing someone's point of view, even on the news…because the spin you'll get on it depends on who's delivering it.* (Jacob-IV1)

These comments indicate students' awareness of the potential for bias in the way information is presented. Their responses imply scepticism regarding the believability of information. Jack rightly suggests that he will believe journal articles due to those publications being peer-reviewed. The peer review process, according to his implication, is a quality assurance process that ensures the credibility of published information.

In gathering their information, ten from thirteen students said they would weigh the information, looking for a balance of positives and negative points which they called pros and cons. Two examples are given below:

> *…consider the pros and cons of the information and there has to be a balance in order for me to decide what to choose to believe.* (Thomas-IV1)

I am a logical thinker and I like to know what the 'right' answer is. In radiography, we deal with facts, so it's important to know the right answers. Everything boils down to positives and negatives. Show me the evidence and then I will believe you. It has to be logical and make sense for me to believe it. (Charlie-IV1)

Alluding to positives and negatives correlates with weighing the pros and cons of information. This amounts to appraising information in search of a balance of reasons that would contribute to them deciding what to choose to believe or not and constitutes their reasoning process. From my professional experience of assessing student assignments it is clear that most students perceive the word 'critical' to mean something negative, especially in their early years of an undergraduate degree programme. Tutors, in my experience, often wrongly assume that students understand what the term means. Critical thinking, in relation to the appraisal of information, means weighing up of the strengths and weaknesses of an argument and deciding where it may fit very well within the literature and where it does not. It is also about analysing what the writer is saying in the article, research or literature. Support for this explanation can be found in the work of Bailin and Siegel, where they state that "it is the assessing of statements to judge that information meets the criteria for acceptability" (2003:183). So being critical is about the ability to interrogate or raise questions about the research, or the evidence, to find out about what works and what does not work within the argument as a whole. We, as tutors, take it for granted by assuming that students understand critical thinking, yet students focus mainly on the negative and forget that the 'positives' are part of the appraisal. They, therefore, take the word 'critical' in its pejorative sense. This lends support to the comments made by both Thomas and Charlie above. Similarly, Emily (IV1) said the following:

…by weighing out all the points… information, analysing it finding out what's important and relevant and what isn't. Then you can make a decision. I can't put it into words, but I know when I'm doing it.

Emily concurs with the responses above in that she would 'weigh out all the points,' but added that she would analyse the information to determine its relevance. She used the word 'analyse'; analysis of information is deemed to be a skill of critical thinking (see Chapter Two). She further suggested that she would then make a decision. Deciding what to do or believe has been defined as critical thinking as discussed in the literature review chapter. When asked about how she knows when she is 'doing it', she replied:

…when you look at something and you are actually able to take the position that it makes sense.

Emily is suggesting here that information has to make sense. Making sense of information is akin to understanding the meaning of information in a logical way, which is inferred by Emily's statement.

Three participants presented different views on the meaning of critical thinking, at this stage (interview one), as indicated below. Their views run counter to the comments made by the majority (n=10) of the students as follows:

> *I would say you take something, you read it then you think why did you do that, why did that happen? But I'm not entirely sure if that is what it's about.* (Isla-IV1)

> *…thinking around the subject in great depth rather than just applying simple basic knowledge to a certain situation. However, I'm not sure that this is true as I'm not sure of the definition of critical thinking.* (Isabella-IV1)

> *I don't know what critical thinking means…sorry…cannot answer that one.* (Chloe-IV1)

In these examples, even though participants indicated they did not know what critical thinking meant, Isla and Isabella, for example, suggested there was more to the thinking process in relation to critical thinking. What is meant here is that they are showing some sort of understanding of the distinction that exists between thinking and critical thinking. They are suggesting they do not entirely know what critical thinking means. However, what they are saying is that they think critical thinking is something more than perhaps the 'simple' thinking process. Isabella believed critical thinking involved a 'greater depth of thinking', where she contextualised her explanation in terms of a subject. She suggested she would apply a greater depth of thinking rather than just basic knowledge to understand the subject matter, whilst Isla stated that she questioned her (Isla's) thoughts. Both students were unclear and uncertain showing a tentative grasp, yet their responses indicate the beginnings of an understanding of critical thinking. Thus, even in this inchoate articulation, an understanding of the meaning of critical thinking shows signs of development. Chloe, however, indicated she did not yet know what critical thinking meant at this stage of her learning. This is an understandable response because she is at the beginning of the first three years of the programme. As the researcher, I assumed many of the students would say the same thing at the first interview. But only one participant admitted to not knowing anything about what critical thinking meant thus presenting only one instance of a disconfirming view in the first year.

In answer to my question, "do you think everyone can think?", students stated that in their opinion, it was apparent that some students either do not like to think or choose not to think while some like to be 'spoon fed' information. Isla (IV1) offers her view below:

> *I think some people just can't be bothered, I think real in-depth decision making is really hard. I would say everyone is capable. I have never met anyone who couldn't think about things, but some people choose not to do it.*

Similarly, Jacob (IV1) said the following:

> *Some will get on with work while others would like to be 'spoon-fed' the information.*

According to Jacob, some people choose not to think about the thinking required for decision-making, whilst others would like to be spoon-fed. Thinking becomes perceived as complicated and 'really hard' and they are unable to analyse and evaluate information, so they prefer to choose the easier option by deciding not to think. This could be one of the reasons why students perform the critical analysis requirement of university assignments at a lower level of achievement. Similarly, unwillingness to think may be the reason why students simply make statements without the necessary engagement and analysis of evidence. As a researcher and tutor, I think it might well be a possible explanation. Within all healthcare professions, practitioners do not have an option not to think. They are all required to meet the expectation for critical thinking and decision-making in autonomous clinical practice as stipulated in professional and regulatory guidance from the HCPC and SCoR (See Glossary, p. xi). However, possessing the skills of critical thinking is insufficient to be considered a critical thinker. One has to take action by doing something to put the critical thinking skills into practice, i.e. one must have the disposition to use their thinking and act critically (Halpern, 1989). It is, therefore, a significant concern as highlighted by Isla and Jacob above.

4.2.2. Responses from the second phase student interviews

During the second phase interviews, some students did not perceive a change in their understanding of critical thinking from the previous year (2013) but agreed that it had been easier to speak about critical thinking in their second year of training as compared to when they were in their first year of study.

Six out of thirteen students attributed their understanding of critical thinking to analysis and evaluation of information, similar to the interview one responses, spoke about problem-solving as a development of their understanding of critical thinking. Two examples are given below:

> *I think critical thinking is taking a certain problem, breaking it down and finding the best way to solve whatever the problem is.* (Amelia-IV2)

Similarly, Lola (IV2) stated the below:

> *I realise now that it* (critical thinking) *is a part of most thought processes, especially in work-related situations when breaking down a problem.*

Apart from analysing the information by 'breaking it down' students will reason what is important and what is not. This appraisal of information is equivalent to the evaluation of information. Evaluation of information is a skill of critical thinking. In their responses, students are indicating very clearly their understanding that critical thinking involves analysis and evaluation of information. Both Amelia and Lola attributed their understanding of analysis and evaluation in relation to solving a problem. Lola clarified that she understood critical thinking to be a part of most thought processes used in 'work-related situations' when solving a problem. 'Work-related situations' is akin to clinical radiographic examinations which require a critical thought process to solve a problem. In the literature, critical thinking skills are used synonymously with clinical decision-making and problem-solving (Jeong, 2015). It is no surprise therefore that students linked their developing understanding of the meaning of critical thinking with problem-solving, particularly in a clinical context.

Another change in perception of critical thinking was offered by Olivia (IV2) who perceived her critical thinking to have changed in the sense that she "*was less judgmental*", and now questioned how her actions might affect others. When asked about what factors influenced the change she said the following:

> *…it will be through placement because you have more eyes on you and you are interacting more with the public who have not known you beforehand and you start to see how things you do are perceived differently by different people.*

'The public' here refers to patients with whom students interacted with within a clinical environment. Patient perception of them was deemed to be important, and Olivia became aware that her actions were being perceived, as she said, 'differently by different people.'

Ten out of thirteen students felt they were able to take in and weigh more information as compared with their first year of study. Students recognised that there was more to the meaning of critical thinking than they understood in the previous year (year1). They thus perceived their understanding to have changed as articulated by Thomas and Isla, for example:

> *My mind has been opened to a lot more possibilities...actually one could argue that my views have changed because I am able to now think in a broader context.* (Thomas-IV2)

> *Everything needs to have a balanced argument…I think with a much more open mind now.* (Isla-IV2)

In these students' first year of study, their scope of learning involved routine examinations and practice on ambulant patients, where they were not required to consider options in imaging or adaptations of radiographic technique. An ambulant patient refers to a patient who, despite

their injury, is able to walk and move with relative ease, in comparison to a patient who is lying on a trolley or bed. In their second year of study, however, their scope of learning involved dealing with more complex imaging examinations on less ambulant patients which required the consideration of likely options in imaging. This could be a plausible reason for their change in understanding of the meaning of critical thinking and is another sign of students' development of critical thinking from their first to the second year of study.

However, there was a tendency to regard all thinking as critical thinking as expressed by Charlie (IV2) below:

> *I can't really envisage thinking without critical thinking – for me, they're one and the same.*

This is an unusual view from Charlie in comparison to the other students, for example, Isla (IV1) and Isabella (IV1) who made the distinction between thinking and critical thinking. This again presents a disconfirming view which conflicts with other views. In comparison to Charlie's view above, Isla (IV2) offers the following:

> *No there are definitely times when you don't have to think, for example, what to eat. Critical thinking takes longer than normal spontaneous thinking…there is a difference between thinking and critical thinking.*

Charlie's view that thinking and critical thinking are 'one and the same' can be considered as not knowing the difference between thinking and critical thinking and appears to be an over-simplification of critical thinking. Charlie therefore wrongly assumes that all thinking is critical thinking, however, what is unclear is whether he was thinking about critical thinking within a radiology context in this statement. In contrast, Isla clearly states that thinking and critical thinking are not the same. Isla demonstrates further development in her understanding of critical thinking from the previous year, where she stated that critical thinking was thinking about a subject 'in-depth'. Here she has built on her understanding of the meaning of critical thinking by clearly stating that a difference exists between critical and non-critical thinking, demonstrating growth from her first to the second year of study.

Furthermore, in relation to radiography practice, below is what Olivia (IV2) stated:

> *As we progress all the stuff we learn has generally become mechanical –we don't really think about it. Even now I can honestly say that I could automatically do a chest X-ray without thinking about it critically.*

Here she rightly makes the distinction between mechanical thinking and critical thinking by referring to the performance of routine examinations as not requiring critical thought. She suggests that routine actions occur mechanically rather than through the application of critical thinking. Olivia clearly gained experience in clinical placement in carrying out routine chest X-ray examinations by stating that she did not need to think critically about performing the

examination. This is due to her experience gained during her first year of training: conducting chest radiographic examinations competently, formed an outcome of their assessment. Olivia feels that performing a routine chest X-ray for an ambulant patient over time became a familiar procedure because over time she used little thinking due to the habitual nature of a patient presentation and the examination. There is, therefore, a level of comfort with performing routine chest examinations. However, if she was faced with a request for a chest X-ray on a patient who presented in a wheelchair or a trolley, then she would have to think of alternate ways of performing the examination. In this case, she would need to use her cognitive and affective skills which are skills of critical thinking. Similarly, if students at Level five were asked to perform a CT scan of the chest, then the thinking process required would need to change to engage their critical thought process. Thinking through the details when undertaking complex examinations and procedures and being able to justify the need for the examination as well as think through the best way to perform the examination when the routine option is not available, is of central importance in radiography specific critical thinking. Olivia, therefore, understands that different thinking skills may be used in different situations and that thinking can be critical and non-critical. This shows similarity with the comment from Isla above and is an indication of her (Olivia's) developing understanding of the meaning of critical thinking at this stage in the programme.

4.2.3. Responses from the third phase student interviews

Findings from the third phase interviews revealed that while some students had not perceived a change in their understanding of critical thinking from year two to year three, some perceived critical thinking to mean a deeper form of thinking. Below is what Lola (IV3) said:

> I still don't get what critical thinking means. I think it is thinking on a deeper level but that's about it.

This is an admission of not being able to say whether she understood it or not, yet she made the distinction that it was a deeper form of thinking, implying that on one hand is 'thinking', and on the other, is another type of thinking, viz. 'deeper thinking'. This shares similarity with the responses from the second-year interviews discussed previously. When explored further Lola (IV3) said she perceived the 'deeper level' to mean the following:

> …being asked to critically discuss and critically analyse. It is about knowing about a subject and then tearing it apart. Going into the topic to do further reading.

Similarly, Isla (IV3) mentioned:

> …in critical thinking, the main difference is that you give things more thought.

These students imply that by doing further reading, or giving more thought to what you were doing, was perceived to help go in-depth about a topic to 'tear it apart'. This amounts to analysis and evaluation of information and correlates with responses from the second phase interviews. The idea of deep thinking alludes to a conscious effort to think deeply about the situation at hand, compared with a superficial effort. However, in comparison to Lola's very insightful link between critical thinking and problem solving, from interview two, she appears somewhat confused about the meaning of critical thinking at the beginning of her third year of study. A possible explanation could be that in the third year of study students are undertaking more complex and advanced imaging procedures, as compared with their second year. The complexity of examinations, in their third year of study, presents new learning which is perhaps 'shaking the comfort zone of their knowledge and understanding.' This could be a possible reason why Lola appears unsure. This additionally indicates that growth in understanding the meaning of critical thinking is not a linear process but shifts backward and forwards according to the context of the time. Students may go through shifts in their learning and development which present differential challenges to them. In other words, it is a dynamic and non-linear development which is subject to the learning required for new clinical, imaging procedures. Development of critical thinking is discussed in the following chapter. Biggs (2003) explains that a superficial approach to learning involves a student typically undertaking a task with minimal effort at a lower level of cognitive engagement to meet the requirements of the task when higher levels are required to undertake the task properly. In this approach, students can meet the minimum requirements and thus pass the assessment, for example, with minimal effort. In contrast, a deep learning approach is when students use higher levels of cognitive engagement to delve deep (below the surface) within a topic area to learn in a meaningful way, i.e. "at a high conceptual level" (Biggs, 2003: 17). One way to do this is by doing further reading at a deeper level as stated by Lola above. Lola started off explaining that she did not actually perceive a change in her understanding of critical thinking, but then alluded to deep thinking; deep thinking is critical thinking according to Glaser's (1941) definition (see Chapter Two). It is possible therefore that Lola developed critical thinking skills without being fully aware of it.

Nine out of thirteen students felt they approached their university assignments in a different way and noticed a change in their attitude and thinking process from year two (2014) to year three (2015). For example, below is what Isabella (IV3) said:

> *I found that I went about doing my assignments in a different way. I think more about what I am required to do. It required me changing my mind-set, my attitude and thinking process. Clinical placement and working with patients has influenced my understanding of critical thinking. It was more the clinical placement that influenced it rather than the university.*

Here is an indication that her understanding of the requirement of critical thinking in relation to their university assignments had developed from her first year of study. She noticed a change in her attitude and confidence which affected her thinking process in relation to how she undertook her assignments. There appears to have been greater engagement with assignments by the words, '…think more about what I am required to do…change of mind-set, attitude and thinking process.' Isabella speaks about a change in her mind-set, attitude and thought process. She also makes an explicit statement attributing the growth in understanding of critical thinking in relation to clinical placement experience as compared with the university. A possible explanation could be that the clinical environment provided students with the opportunity to apply their university learning, and this was seen to have influenced Isabella's understanding of critical thinking.

Similarly, Jacob (IV3) said the below:

> *I understand why tutors are saying what they said in my feedback. I was thinking that I was good so why was I getting this kind of feedback. When I sat with my university markers and they explained their feedback, I learned a lot. Last year taught me that there is more than one way of doing things. I learned to take in other points of view and think more broadly.*

This statement demonstrates that his thinking process and understanding has broadened from his previous year of study. He was able to learn from his feedback at the university. On discussing his feedback on university assignments with tutors, Jacob expressed an understanding of what the feedback meant to him. In addition, a very important point here is that Jacob learned about alternative ways of doing things, i.e. 'more than one way.' An aspect of using critical thinking skills is the ability to consider alternate views and optional ways of 'doing things.' This was a development from, perhaps, repeating actions in assignments as they had been done during the year before (second year). This indicates a development in his understanding of critical thinking from year two to year three. Halpern (1989) states that good thinkers, instead of becoming defensive about their feedback, learn from their mistakes. This is evident from the statement above. Jacob demonstrated critical thinking skills development in this comment by demonstrating the disposition of being flexible to consider alternate views and options.

4.2.4. Responses from the tutor interviews

Like students, responses from tutor participants indicate that they too perceive critical thinking to involve the analysis and evaluation of information and evidence. They also believe the

thinking process involves deep thinking about the issue at hand in the light of the bigger picture and which impacts on their reasoning process as stated by Mia below:

> *…critical thinking is a deeper form of thinking where you need to consider the evidence and its validity in relation to the bigger picture, and then process the information with the aim of making a decision or judgment.*

She also suggested that the aim of the critical thinking process involves the processing of credible evidence with the purpose of deciding or giving an opinion. Critical thinking, therefore, is not just the *product* of the thinking process but the actual *process* of thinking as well. Another example is given by Grace below:

> *I always think of it as academic but I know that there is more to it than that. In terms of academic writing and considering what is required for that, it is not only about making decisions but is also about taking information from places, weighing up their value and making your decision. The fact that you really have to weigh up the value is what makes it critical. So, if you are looking at the evidence it is about evaluating how much you believe the evidence and then making a decision about whether that can be applied to your situation, like making clinical decisions.*

Whilst at a much higher level of articulation, similar to the students, Grace felt the analysis and evaluation of the believable evidence was the critical thinking aspect of the thinking process. She would then use the evaluation to make a decision which could then be applied to a clinical situation. Interestingly in Grace's statement, however, she thought of critical thinking 'as academic.' This could be a possible reason to explain why, despite understanding the term, academics are unable to explain its meaning to students in a way they can understand. Perhaps tutors think there are differences in how they understand its meaning in relation to how they are expected to explain it to students. From my professional experience tutors struggle to explain the meaning, and requirements, of critical thinking to students. See Chapter Seven for more discussion on this issue.

4.2.5. Summary of findings in relation to the sub-theme, 'critical thinking as logical thinking involving the evaluation of information'

Both students and tutors related their understanding of critical thinking to the appraisal of information to decide what to accept or believe. In the case of tutors, it was deciding whether to use the information in their reasoning process when making clinical decisions. Tutors further elaborated that the analysis and evaluation of the evidence was the critical part of the decision-making process. Tutor responses matched those of students. During the exploration of the meaning of critical thinking, the participants attributed the process of weighing the pros and cons of an argument as critical thinking.

The students stated that they would trust reliable sources of information and consider multiple views rather than individual perspectives. They also stated that information needs to be logical and factual for them to make sense of information. During their first-year interviews, students linked their understanding of the meaning of critical thinking with evaluating information to make a decision. Following that, with a bit more experience, they perceived this to mean problem-solving. They perceived the thinking process to involve breaking down of a problem with an evaluation of the component parts to help them solve a problem.

The students generally found it easier to speak about critical thinking during their second-year interview as compared with their first-year interview. Most were able to compare their understanding of critical thinking to their previous understanding in year one and to speak of any changes in their perception thereof. Feedback on assignments at university and experience gained from learning at clinical placement were factors that influenced the change in their understanding of critical thinking.

Some students did not perceive a change in their understanding of the meaning of critical thinking during the second and third phase interviews. Some perceived critical thinking to mean a 'deeper' level of thinking drawing the distinction between non-critical thinking and 'deeper thinking' which was critical thinking. What came across very strongly, during the second and third phase interviews, was how placement shaped their understanding of the meaning of critical thinking by enabling them to become flexible and open-minded in their thinking. These are demonstrations of dispositions of critical thinking.

4.3. Critical thinking as the process of decision-making

In this section, the findings in relation to the above-mentioned subtheme are presented. The participants spoke about critical thinking as a decision-making process where the outcome, goal or product of the thinking process was the decision.

4.3.1. Responses from first phase student interviews

A strong link with the process of decision-making emerged in relation to understanding the meaning of critical thinking. Two examples are given below:

> *…critical thinking to me is about decision making, looking at the decisions you have made and deciding whether they are right or wrong.* (Thomas-IV1)

> *…I think critical thinking is about exploring one's thoughts while making a decision rather than just thinking it and doing it straight away.* (Lola-IV1)

In the above two cited responses a big impact was seen in the students' awareness of critical thinking in their decision-making process. In thinking about the decisions made, they stated that they would evaluate their thoughts in light of the decisions. Evaluating their thoughts would require a deep rather than superficial thinking process. Critical thinking has been described as 'deep thinking' in the previous section. Thomas and Lola here, by linking their understanding to their decision-making process, imply that critical thinking is a deep-thinking process which is essentially allied to physical, emotional and moral considerations in the clinical setting.

Most participants acknowledged that there was a purpose to their thinking process and that the product of their thinking was a goal. Olivia (IV1) stated the following:

> *The purpose of my decision was to have a career for myself and be able to get a good job and a good future. I enrolled in the course, so it was a purposeful decision and action.*

A similar account was offered by Isabella (IV1) who said the following:

> *…my goal from my thinking process during my A-Levels was to get onto a course, so the end of my thinking process resulted in a goal.*

Olivia linked the goal of her decision-making to getting together a plan for a 'good career and future.' The purpose of her decision-making was clear, and she took action by registering onto a course, similar to Isabella. Olivia and Isabella had not been to clinical placement by this time, so their examples relate to major decisions surrounding their choice of a university course, i.e. their goal, which rightfully required careful thinking and decision-making.

A goal could also be perceived to be an action as asserted by two students below:

> *…I would make a decision and that would influence what I would do. Decision always comes from the action…and reasoning guides your actions.* (Harry-IV1)

> *…my understanding of critical thinking…is about weighing up the factors and knowledge that you already have in order to come to some kind of appropriate judgment to help you reach the goal of deciding how to act.* (Sophie-IV1)

Harry suggests here that his decision would influence his action. He explained he would decide what he needed to do before taking action. He further stated that he would use reasons to guide the action he took. His action was perceived to be the goal of his thought process. Similarly, Sophie stated that she would use her knowledge to help her make a decision that would determine her action. In her response, she appeared to consider the action as the goal of her thought process. Goal driven thinking is not impulsive thinking. Making a decision about

health, illness, and treatment is a major decision and requires critical thinking. In relation to diagnostic radiographic practice, the goal of the thinking process is decisions affecting patient examinations, diagnosis, outcomes and patient care and well-being. The decision-making process is crucial to the action taken and therefore rightly acknowledged by the students above. However, contrary to the other students, Charlie (IV1) said that:

> *…to me critical thinking means thinking, just thinking. I don't know any thinking that isn't critical. I suppose really it will be defined as thinking which leads to a determined outcome…an end goal. But I do that all the time...*

Here there is clear perception, from Charlie, that all thinking is critical thinking. There is also a sense that critical thinking is a straight-forward and unproblematic process. If it were then I would not be writing about this subject. As a researcher, I believe critical thinking is a contentious and sometimes painful process which is often a struggle to achieve. In some cases, one needs to make quick decisions requiring superficial thinking, as mentioned in the previous section. Critical thinking is therefore not required all the time. Once again, this was another example of a disconfirming view articulated by one student.

In relation to decision-making, eleven students spoke of evaluating reasons to balance arguments. Two examples are presented below:

> *Each time I would balance my argument and reasons with the requirements of what I wanted to do, and which would benefit me the most. I did enough reading before to ensure that my reasons were reliable.* (Sophie-IV1)

> *It is important to me to get different points of view. Sometimes the whole truth is not presented, and this affects the reliability of the information and the source of where it has come from. You have to weigh up the different views and decide which are reliable to use so that you can justify your reasons.* (Isabella-IV1)

For Sophie to make a decision, based on reasons, she ensured she read about the course and her options. The reasons for making a decision were therefore considered sound, 'reliable' reasons which she could use to create a balanced argument. As such in Isabella's example above, she chose to consider multiple views so that her reasons could be justified as reliable. Isabella's response demonstrates useful insights into her deep thought process. She made clear statements about ensuring that information is unbiased, so she can use that in her decision-making process. The ability to make prudent, unbiased decisions is a disposition of critical thinking.

One student, however, felt indecisive and wanted to see the bigger picture to help direct her thinking as indicated by Amelia (IV1) below:

> *I'm indecisive and certain situations are not clear-cut and straightforward and you have to think.*

There is an assumption here that you do not have to think during 'clear-cut, straightforward situations'. A 'clear-cut' situation here implies a situation that involves routine action which is uncomplicated. Some tasks do not require critical thinking while others do. Situations that are not 'clear-cut and straightforward' require critical thinking skills. Amelia is therefore correct in her understanding. What was underscored, however, was that:

> *…it's a learning process. Some decisions can be made quickly, and others need a bit more time. The hospital can be a fast-paced environment, but experience again plays a big part in this. The thinking might change depending on the situation.* (Jack-IV1)

Like Amelia above, Jack asserts that some decisions can be made quickly, requiring little or no critical thinking, whilst others need critical thinking and take more time. Jack speaks of the situational influence of the environment involving quick decisions. Although Jack did not have experience of clinical practice at the time these interviews were conducted, he appeared to understand correctly that decisions must be made quickly in a clinical environment.

Nine out of thirteen students found that making complex decisions helped refine their understanding of critical thinking over time. Thomas (IV1) exemplified what he understood by a complex decision as follows:

> *Could be anything in any situation but which involves a number of different things to consider and not something that is straightforward. You think about the consequences of that decision or the impact of that decision. You think about what outcome would be best for which. Prioritise one over the other or waiting to see how one impacts before thinking about what to do for the other.*

In addition, Isabella said that:

> *…in a new situation, I would have to figure out a number of things because I have not been in that situation before. I would again break things down into smaller chunks and weigh up options.* (Isabella-IV1)

In these expressions, students took the similar view that different criteria require consideration in complex or new situations. Thomas, in his statement above, clearly described a situation complex enough to cause a dilemma. By speaking his thought process out aloud, he was able to indicate the application of his critical thinking skills through his consideration of many different criteria required in making a decision in a complex situation. Consideration of criteria could be the weighing up of likely options in the imaging procedure and the consequences for the patient. Similarly, Isabella states that she would consider the necessary information and analyse the information and options before proceeding because the situation was new, and therefore, unfamiliar. This implies that in a 'new' situation, she would not apply superficial thinking, she would think critically. For example, at Level four, students are expected to conduct a chest X-ray examination on an ambulant patient. It is expected that a student will

develop proficiency in this examination on an ambulant patient. Students will gain experience and become proficient in undertaking this examination during their placement. However, should they encounter a patient for a chest X-ray examination who is either in a wheelchair or on a trolley, this will be a new situation for the student. The student, therefore, will need to consider many more factors in this situation than they would have a need to in the former situation and will need to think critically.

Strong links were made between emotion and the decision-making process. Two examples are given below:

> *I think people make superficial decisions all the time like what I want to eat for dinner. There is not a great deal of thought that goes into that, but breaking up with my boyfriend was a serious decision. They are the ones that you have to think about whereas with the superficial ones there is less emotional involvement and fewer ramifications.* (Isla-IV1)

> *…some forms of thinking involve emotion, those will not be considered as critical thinking. Critical thinking is more objective thinking that follows a logical thought process. (*Amelia-IV1*)*

In Isla's statement above, she spoke about how difficult it was to make a decision due to the extent of the emotion involved with it. The thinking processes are perceived to be different here with the simple thinking having less emotion and fewer consequences. This implies that critical thinking is involved in making 'serious' decisions which involve emotions. However, contrary to Isla's statement, Amelia asserts that critical thinking is objective thinking and therefore follows a logical thought process devoid of emotion. She elaborates that there are 'forms of thinking' implying different types of thinking, some of which involve emotion. She feels that critical thinking is a type of thinking that does not consider a person's emotions. Critical thinking is not solely cognitive and cerebral but needs to take into account a patient's wellbeing. Emotion, according to Simpson and Courtney (2002), does affect one's ability to think critically and is an integral part of critical thinking in diagnostic imaging. Emotion translates into empathy in professional practice, where radiographers are expected to consider all factors in their decision-making process, but to make a decision that will benefit an individual patient. Putting patients at the heart of our services is one of the principles and values of the NHS as stated in the NHS Constitution (2015). In the literature, critical thinking skills are referred to as scientific thinking skills (Kuhn et al., 1988). Guidance on critical analysis by Judge et al. (2009), for example, focuses on explaining what the higher order skills were. This guidance was provided to assist students in writing their essay assessments. Within this guidance, however, there is no mention of affective skills or dispositions within the critical thinking framework. Although Amelia's view appears short-sighted in light of literature she is

demonstrating her understanding based on the guidance she has been given thus far. This, therefore, raises an implication for consideration in relation to pedagogy.

4.3.2. Responses from the second phase student interviews

In keeping with the topic of emotion in relation to decision-making, following the second phase interviews, students noted that emotion continued to play a significant role in their decision-making. Two examples are given below:

> *…this year I have definitely become more emotional in my thinking. When you are objective and logical then emotions do not get counted in at all. If you don't use emotion, then you can lose the ability to care or show empathy to your patients.* (Olivia-IV2)

> *…people who are factual thinkers may not be emotionally attached. In terms of attitude, I think that they are more likely to have a tunnel view, but emotional thinkers do think about how the goal will affect others, and how it will affect you while achieving the ultimate goal.* (Chloe-IV2)

Olivia makes an interesting comment which implies that in thinking logically and objectively, no emotions or feelings are considered, similar to Amelia (IV1). If this is perceived to be the nature of thinking critically then there is an element of concern in relation to the ability, or lack thereof, to care for patients. No critical thinking is entirely cognitive. Critical thinking skills involve both cognitive and affective skills, the latter of which involves emotion (Halpern, 1989; Facione, 1990). Emotion is an important predictor of caring dispositions in students, and demonstration of empathy in patient care is paramount in daily radiography practice. In Chloe's statement above, she suggests that those who consider emotional factors, when thinking about their 'goals' in relation to decisions, are more likely to consider the wider implications of the decision. This is thought to affect both the person who is making the decision (student radiographer), as well as whom the decision is being made for (patient). Chloe suggests that people who focus on facts may exhibit 'tunnel views' by not engaging in big-picture thinking which involves caring for others. She speaks about the impact of the goal, or decision on both other people, and to oneself; this implies consequences. When we think about the consequences of the decisions we make, we demonstrate empathy. Empathy is an affective skill and disposition of critical thinking (McPeck, 1981; Halpern, 1989; Facione, 1990).

In the process of making a decision, one participant stated the following:

> *… if I have a complicated case come in and I am weighing whether I am going to X-ray them or not then I am weighing up what's best according to my morals. As a radiographer, I will have to weigh up decisions according to the morals of the NHS, which may not necessarily always match mine.* (Harry-IV2)

Here Harry said that he would not only have to weigh up information according to his own beliefs and values but also according to those of the NHS, which he perceived may conflict with his own values. An example of such a dilemma would involve informing the parent of a fifteen-year-old patient that they are pregnant and the required X-ray examination, therefore, cannot proceed, despite the patient asking you to keep the information confidential. This action on the part of a radiographer has ethical and moral consequences if you believe as a radiographer that a parent has a right to know. Ethics refers to the rules of conduct associated with a class of human action, group or culture, for example, medical ethics (Dictionary.com, 2018d). Morals, on the other hand, are founded on the fundamental principles of right conduct rather than on legalities, enactment or custom (Dictionary.com, 2018b). Morals refer to a person's ability to act in a manner that distinguishes right from wrong, i.e. their moral attitude (Ramlaul & Gregory, 2013). A scenario, such as that given above, can conflict with the moral beliefs of a radiographer. Upholding the values of the NHS is an expectation for professional practice; Harry rightly identifies the need to be able to weigh up his decisions according to expectation. In so doing he demonstrated his awareness of the need to think objectively when faced with circumstances that called into question his own beliefs. Some examples of NHS Principles and Values are: working together with patients; respect and dignity; commitment to quality care; and everyone counts (NHS Constitution, 2015).

The guidance underlying these values state that service providers must put patients' interest first, before personal or institutional interest. Another important set of values guiding the delivery of radiography imaging services are the 2015 NHS 6Cs: care, compassion, courage, communication, commitment, competence. In addition, the NHS Principles and Values for service delivery align with SCoR and HCPC expectations of professional practice. Therefore, decision-making for a patient needs to consider a patient's personal disposition and beliefs. Importantly, therefore, Harry's ability to recognise the conflict with his morals, and those of the NHS, is a metacognitive or reflexive action on what he was doing. If Harry was thinking about the right decision to make or the right thing to do, then that might be his reflective thought process. However, if he was looking at himself and understanding why he was making the decision then that is an indication of his self-awareness. He demonstrated this by self-understanding. This is an indication of his metacognitive thought process.

Similar to Harry above, below is what Amelia (IV2) added:

> …it has a lot to do with your morals, your nurture and what you were brought up with. People always say, 'keep your conscience clear', so if you do what is right for other people then you can keep your conscience clear. In this way, you are always doing what is best for the other person regardless of how you feel about it.

These responses allude to their perceived ethical obligation to do what is 'right' for a patient and is a key consideration for a healthcare professional. Ethical considerations constitute a disposition required for critical thinking to take place. The NHS Constitution (2015) sets out the expectation of a healthcare professional in caring for patients within the NHS, as previously mentioned. Amelia understands that these attributes are cultivated during a person's growing years where parental guidance is influential and instrumental in nurturing these attributes. In addition, Charlie (IV2) states:

> …you can't say that something is morally wrong just because it goes against the majority thinking?

In Charlie's statement, there appears to be an appreciation for logical thought and sensible thinking especially in its application to a moral purpose even if it is deemed to go against the flow of the opinions of others.' 'Majority' here possibly relates to the opinions of radiographers in the clinical environment.

Twelve out of thirteen students additionally recognised that there is responsibility in making a decision for the patient. Two examples are given below:

> I have to have the ability to consider what the best outcome is for the patient. Basically, why am I doing what I am doing? I have to reason out what I am doing. I have to ask myself if I am doing the right thing for the right reason. Can I justify the decision I am making based on the knowledge I have today? Should I do just what other people have asked me to do? But you can't, you have to think for yourself… because you are weighing perhaps internal politics and the patients' health. But the primary goal involves considering what's right for the patient. (Jacob-IV2)

> …you have to put yourself in their shoes. But when I do this I assume that everyone is doing so and I know that most people don't. (Chloe-IV2)

Here there is a strong focus on doing what is right for a patient. 'Right' is considered in terms of its moral sense. In his statement, Jacob demonstrated self-awareness of his thinking process, the decisions he made, resultant actions and consequences. Jacob understood that perhaps conflicting views may impede his decisions, but he had a desire to ensure that patients have an outcome that is right for them. One example of how internal politics may play out within the radiology department is when a patient presents for a follow-up examination of his/her hip following surgery and you as the radiographer notice the prosthesis has moved. Prosthesis is an artificial body part. It is inserted in patients undergoing surgery for hip or knee replacements, for example, to replace a dysfunctional joint. You understand, as the radiographer, that this finding will mean significant delays in the healing process of the affected bone. You raise your concern with the senior house doctor on duty, who refuses to get an orthopaedic assessment and therefore sends the patient home. The next time the patient will

be seen will be at a follow-up orthopaedic appointment in three months' time. In this example, the radiographer took the right action by raising their concern with the doctor. The doctor, however, refused to listen, and the patient thus would bear the consequences. The consequences in relation to this scenario are delayed healing with the possibility of further surgery due to the displacement of the prosthesis. Jacob understood that he would have to think for himself rather than 'simply do just what other people asked him to do.' To do this and understand the patient perspective, Chloe rightly said that you have to 'put yourself in their (the patient's) shoes.' In her statement, she raised a concern saying that most radiographers or perhaps healthcare professionals do not do this. Jacob and Chloe, therefore, affirm the importance of doing what is 'right' for the patient.

4.3.3. Responses from the third phase student interviews

Similar to the second phase interviews, responses from the third phase interviews indicate changes in understanding of critical thinking were seen in the students' concern regarding the consequences of poor decision-making. Two examples are given below:

> *When you are making a decision for the patient, especially a complex decision, you realise that the decisions you make have a bigger impact than you initially thought. It makes you take a step back and consider the decisions you make a lot more critically.* (Thomas-IV3)

> *There is no point in thinking critically if you cannot verbalise it or use it to improve what you do for the patient. A lot of students think critically but they don't want to question or challenge. When you are making a decision for another person, your thinking must be clear so that you make the right decision.* (Jacob-IV3)

These comments, like those from the second interviews, make strong links with decision-making and the responsibilities associated with making a decision. Both Thomas and Jacob acknowledge that the decision must be right as they perceive that would have a positive impact on a patient. This concurred with all student participants. It provided a good indication of big-picture thinking considering the ethical principles and consequences of making a decision for the patient. Jacob's statement that critical thinking requires the same sort of verbal or active response aligns with Halpern's (1989) and Ennis's (1989) definitions of critical thinking, which speaks of 'deciding what to do or believe.' Jacob affirms that clear thinking is required when making a decision for another person. Students may have the skills for critical thinking, but may not have the disposition to act critically, by challenging or questioning. The underpinning confidence in the statements of Thomas and Jacob implies assertiveness to do what it takes to make the right decision. Assertiveness and confidence are dispositions of a critical thinker. Their comments, therefore, demonstrated development in their understanding of critical thinking.

4.3.4. Responses from the tutor interviews

Responses from the interview with tutors revealed that they value the importance of the thinking process in relation to decision-making, as explained by Sophia:

> *If you get a request for a chest X-ray, and the information on the form may not fit in with what you consider to be a justifiable request. It's about trying to decide whether this information should be used, or should an alternative be used. So it's about gathering the evidence, deciding how worthy it is and using that to make your decision.*

> *It's quite complicated as you have to consider several things and within the context, you are dealing with. For example, where the information has come from, how reliable is it as a source, how has that information been derived? For instance, with the X-ray form, has the doctor looked at the patient or was it completed by somebody else, how relevant is the information and how recent is it? And it's kind of you having a set criterion for everything that you do.*

Sophia acknowledged that thinking is a complicated process involving consideration of criteria, reasoning and making a decision. 'Criteria' implies consideration of information, for example, related risks-benefit of an examination, patient care needs, radiographic technique and moral considerations. The production of a high-quality radiographic image requires careful radiographic technique involving a dose of ionising radiation. A radiographer needs to carefully consider the criteria on a patient's examination request, including clinical indications, and to ensure that the requested diagnostic information correlates with the criteria provided. In addition, criteria such as age and pregnancy status need consideration due to the harmful effects of ionising radiation on body parts such as eyes, thyroid and the reproductive system. Consideration of these criteria constitutes good patient care and responsible practice, as spoken by Sophia.

In addition to evaluating the 'criteria' at hand, similar to that discussed earlier, tutors advised that radiographers be aware of how personal values influence the way they have analysed the situation to make the right decision. For example, Grace said the following:

> *…especially in cases where the patient cannot be positioned in a particular way, you will have to adapt your technique and use your clinical reasoning abilities to ensure that you get a good quality image but keeping the patient comfortable and safe. So even though you have to consider all the physical things, you also have to be in touch with the emotions that come up. Sometimes you may encounter a patient who may find it very difficult to do something or may need to uncover part of their bodies. You have to think about the whole person and not just what they physically can do.*

This response is a clear indication of the decisions radiographers must make on a daily basis giving due to regard to patient care and patient safety. Grace spoke about the reasoning skills

required in deciding how to adapt your radiography practice whilst keeping a patient comfortable and safe, especially in circumstances when a patient is unable to move easily and follow a radiographer's instructions. Grace mentioned 'clinical reasoning abilities' which are likened in the literature to involve the use of critical thinking skills (Simpson & Courtney, 2002). In addition, Grace importantly affirms that radiographers look after the 'whole person', implying that they consider a patient's emotional state as well, not just their physical state. This illustrates the importance of being able to think critically using both cognitive and affective skills so that those skills can be applied effectively within the clinical environment, as seen in Grace's example.

With regard to ethical practice Mia said the following:

> *You have to think about how we will be able to do this, can the patient do this, and are there other things I need to consider? Even just simple things like asking someone to remove a head-dress for a neck X-ray, for example. It's only really out of hours that their (patients') specific requests may not be able to be made.*
>
> *One of the common ethical decisions I had to make over the years were related to pregnancies where they disclosed that they might be pregnant but that they might be planning on aborting the baby anyway, so they were happy to go ahead with the CT scan. Now I would not be happy to make a decision about that, or to get them to sign to say that. To do that I have to make a decision that involves both the radiologist and the patient on what the risks are in the examination. If it's a CT head scan, then there will be less risk compared to them having a CT pelvic scan. This is where individual values come in and you need critical thinking in a dilemma like this.*

Mia presents an interesting and detailed account of the reality of a working radiographer. Similar to that already discussed, the above comment adds key circumstances that indicate complexities that arise in a radiographer's daily practice. Mia's deliberation over performing a CT scan (See Glossary, p. xi) on a patient who may be pregnant is a commonly encountered situation in clinical practice. The dilemma adds a layer of complexity, in that a referring practitioner may override a radiographer's decision resulting in the scan being performed.

In addition, asking a female patient to remove her headscarf for an examination of her cervical spine, for example, during a day shift may not pose a problem due to the patient's expectation of being examined by a female radiographer. There are likely to be several female radiographers who will be able to undertake the examination, on such a patient, during a day shift. However, if such a patient presents for this examination during an evening shift it is possible that a female radiographer may not always be available due to reduced numbers of staff working the late shift. This situation poses a moral dilemma with respect to such a patient's culturally informed needs. As stated earlier, ethical considerations form an important

part of the decision-making process which cements the understanding that critical thinking cannot be an entirely cognitive or cerebral activity.

4.3.5. Summary of findings in relation to the sub-theme, 'critical thinking as the decision-making process'

Participants perceived critical thinking to involve the evaluation of both supporting and conflicting information, and the use of reasons to make a decision. They felt that critical thinking is deep thinking rather than superficial thinking when explained in relation to complex versus simple situations and that the thinking process is a decision-making one. The purpose of making a decision lies in a specific outcome or a goal. The thought process was perceived to be influenced by various considerations with respect to a patient's condition, such as, physical, emotional and ethical considerations, as well as in keeping the radiation dose as low as possible, while obtaining a diagnostic image. Participants felt better informed about the consequences of decisions made, especially in relation to their emotions. They were inclined to be less judgmental and more flexible in considering likely options.

4.4. Critical thinking as reflection and metacognition

In this section, the findings in relation to the above-mentioned subtheme are presented. There were no responses in relation to this theme from the first phase student interviews. A possible reason could be that students were new to the university and the concept of reflection was not yet part of their experience.

4.4.1. Responses from the second phase student interviews

From the responses obtained during the second interview, eight students stated that they would often think about, and reflect on decisions, they made in the past. Three examples of responses are given below.

> *…it was important to think about the decision later, to reflect and to minimise any errors in future…and enhance your confidence.* (Jack- IV2)

> *…you reflect on what you did, whether it could have been different, and how you would change your actions for the future. The critical thinking helps with the decisions you are to make in the future.* (Thomas-IV2)

> *…You can go back and learn more about the decision as time passes. I do usually deliberate over decisions made long after I've made them.* (Charlie-IV2)

Jack spoke of the importance of reflecting on his decisions after he had made them, so he could improve on future decisions and actions taken. Considering Jack was new to university with limited knowledge and understanding of the process of reflection, he intuitively speaks about the value of reflection in minimising errors and enhancing confidence. Reflective practice is the foundation of good practice and affords practitioners the opportunity to critically evaluate their practice to continue to perform to expectations. Like Jack, Thomas speaks about the value of reflection in thinking about his decisions and whether, retrospectively, he could have made different decisions. The mulling over of decisions, whether they worked or didn't work, requires critical thought. He demonstrated awareness of critical thought in his thinking and decision-making by indicating that he would evaluate his actions. What Charlie is suggesting here is that evaluation of his actions involved thinking about his actions, questioning the previous actions with the hope that it would lead to improved decisions in the future. The 'deliberation over decisions' demonstrates self-awareness of his own thought process, which is akin to metacognition. Questioning one's thoughts and actions is synonymous with metacognition and reflection (Paul, 1990; Schön, 1991). In terms of students developing understanding of critical thinking, they are evaluating their thinking and thinking about their own thinking. Evaluating their thought process is not 'thinking about own thinking.' Thinking about thinking is metacognition and is high-level thinking. There is, therefore, a distinction between 'evaluating one's thinking' and 'thinking about one's thinking.' This bridges the gap between evaluation and thinking about thinking.

In relation to the responses given above, one of the important aspects of the findings I was hoping to demonstrate in my research was that students progressed in their levels of thinking. They were thinking at higher levels of cognition and reflection and the data strongly suggest that this was the case. This is often referred to as metacognition, which is a process of thinking about thinking and questioning your own thinking (Paul, 1990). Metacognition involves critical self-awareness, a reflection both at the present time post the action, and a long time after the action (Duncan, 2017). This involves not only reflection but a degree of reflexiveness as well. Reflexivity involves much more of the person's self and self-examination, particularly of their professional practice. The terms 'reflection' and 'reflexivity' are often confused, conflated and wrongly assumed to be interchangeable. Finlay and Gough (2003: ix) find it helpful to think of these concepts as forming a continuum. At one end stands reflection, defined simply as 'thinking about' something after the event. At the other end stands reflexivity: a more immediate and dynamic process which involves continuing self-awareness. In other words, reflection and reflexivity are two sides of the same coin. The crucial point about reflexivity is that it involves the self in a critical engagement with one's own thinking. In this sense, it is about thinking about one's own actions in the light of reflection and applying to it a self-

knowledge based on experience and knowledge. To put it at its simplest: it is thinking about one's own thinking and actions. It is, therefore, a metacognitive and higher order thought process which has the potential to yield deeper meaning than reflection alone. So, it is critical thinking, reflection, and reflexivity that characterises metacognition. It is an active, conscious process, and through self-reflection, one has the ability to correct one's thoughts. Through self-awareness, one has the ability to be mindful. 'Self-awareness' and 'being mindful' are dispositions of critical thinking (Halpern, 1989).

4.4.2. Responses from the third phase student interviews

The responses from the third-year student interviews indicate strong links between critical thinking and reflection. Amelia (IV3) provided a basic interpretation of how reflection is used to inform past and future actions as presented below:

> …reflection has an element of critical thinking. You require critical thinking in order to reflect on what you have done and how you would change your actions next time. It gives you the confidence to change what you do.

Amelia alludes to changing her actions following reflection. She states that reflection on her actions gave her confidence in her ability to determine how to use her knowledge and skills to change her future actions. Similarly, Jack (IV3) agreed by stating the following:

> … And, if possible, how to do it better in the future. Similarly, self-questioning and reflecting on differing viewpoints in order to help you make the decision for yourself.

Jack speaks about 'self-questioning and reflecting on differing viewpoints; by so doing he is demonstrating traits of critical thinking. By stating 'to help you make the decision for yourself', he is demonstrating his development towards autonomy in his decision-making. This is an indication of his development as a student radiographer from year two to year three. 'Self-questioning' leads to self-regulation, both of which are metacognitive activities. As he developed, therefore, he became self-aware and knowledgeable about his thinking, indicating that he would look at how to improve ('better') his previous decisions.

Another perspective is offered by Isla (IV3) who more assertively said the following:

> I would think the analysis and the evaluation part of the reflective cycle is actually critical thinking. The first part of the reflective cycle (what it was) is a reflection.

Isla, in her statement, separates the reflective cycle into reflective and critical thinking portions. The former, according to Isla, takes place at the beginning of the thought process, with the latter following thereafter. The latter portion is perceived to involve analysis and evaluation of the experience. These skills are recognised as cognitive skills of critical thinking. When

compared to Kolb's (1984) and Gibb's (1988) reflective cycle, Isla's interpretation appears to be correct in relation to the structure of the reflective cycles published by these two prominent authors. Critical thinking, therefore, is an integral part of the reflective thinking process.

Another perspective on reflection in relation to critical thinking was presented by Charlie (IV3) who stated the following below:

> *…reflection is basically past tense critical thinking. Because you are looking back, and you are assessing the positives and negatives of your actions. Not all critical thinking is a reflection, but all reflection is critical thinking. Critical thinking is the umbrella term for any kind of critical thought. Reflection is basically past tense critical thinking…not because it happens in the past, it is because you are engaging your mind with something that has happened in the past.*

In this example, Charlie viewed reflection as 'past tense critical thinking' implying that reflection happens retrospectively. Because reflection on aspects of your decision-making process is taking place after the event, it is perceived to be using critical thinking skills, hence Charlie's comment on reflection being 'past tense critical thinking.' Reflection can take place in-action and on-action and so can critical thinking. In comparison to Isla's statement above where she separated the reflective cycle into reflection and critical thinking, the latter portion of the cycle, which involves analysis and evaluation of the situation, involved critical thinking skills. The beginning of the reflective thought process requires description and explanation of the experience. These skills do not require critical thinking. All reflection is therefore not necessarily critical thinking. Charlie's understanding, in light of this, although insightful and authoritative, falls short of a full understanding of the essential relationship between critical thinking and reflection.

Another interesting perspective is offered by Jacob (IV3) who elaborated as follows:

> *…reflection should always be critical thinking. Critical thinking happens in action, while you are actually examining the patient. You are probably reflecting all the time. You are just not thinking that you are reflecting. Critical thinking and reflection are parallels in thinking. Yes, there is an element of repetitive action, but you cannot be repetitive in everything. There will always be circumstances where you have to think about your actions critically. It's almost a reflective cycle within a reflective cycle.*

Jacob expressed similar views to those of Charlie above. However, he additionally described critical thinking as a 'reflective cycle within a reflective cycle.' This could be perceived as thinking deeply about thinking which amounts to metacognition. Jacob further describes critical thinking and reflection as 'parallels in thinking' implying that they take place simultaneously but creates the distinction that critical thinking takes place while 'actually examining' a patient, whilst reflection happens all the time. He offers that a person is reflecting

all the time but not thinking they are reflecting. Jacob exemplified what he meant by offering the following example:

> *…this came through in one of my assignments very strongly. I got it wrong because I didn't go and ask for help. It was a poster assignment which was something that I'd never done in my life before, but I assumed that because I did everything else okay, I'd be fine with doing that…through my reflection, this incident taught me something about the way I think things through and approach things.*

Jacob considered the poster assignment in the same way he approached other assignments, even though he had no prior experience of compiling a poster. This is where he felt that his over-confidence let him down. He was faced with a different situation that was new to him but, rather than adapting his approach, he used routine thought processes. This, according to him, was where his 'level of critical thinking' was at the time. In this incident, he took the assignment for granted and did not consider the uniqueness of it. The above extract demonstrated growth in Jacob's understanding, through his learning from accurately reflecting on this incident. It takes confidence to acknowledge that a mistake has been made and, that if the situation were to be repeated, one would interrogate it differently. So, although Jacob stated that he did not perceive a change in his development of critical thinking skills, he demonstrated, through his critical reflection that his critical thinking skills had developed, in comparison to being over-confident in year one. By reflecting on his thought process and decisions made, and being aware of his ability or lack of ability, he additionally demonstrated the skills of metacognition. He also demonstrated his reflexivity by being able to speak about how the situation affected him in his learning as a mature student. Jacob feels that the change he made from working in a corporate environment to now being a student radiographer made him more aware of his position within the radiography environment. It is no surprise that Jacob considers critical thinking and reflection as parallels as thinking. He is being reflective and reflexive at the same time, a more accurate statement from Jacob would have been a 'reflective cycle within a reflexive cycle.'

Perhaps a healthcare professional's reflection in and on-action becomes habitual with practice and experience. According to Schön, "practitioners do frequently think about what they are doing while doing it" (Schön, 1991: 275), but explains that reflection-in-action tends to change one's "intuitive performance to knowledge-in-practice" (Schön,1991: 277). Therefore, instead of being guided by intuition which is largely what routine actions are based upon, Schön says that you are guided by knowledge. The thought process that is required in applying the knowledge is a conscious action rather than a subconscious one. Both thinking and critical thinking are active processes. It is possible therefore that critical thinking happens in action,

while you are examining the patient, as stated by Jacob. However, Charlie summed up his belief by offering the following view:

> *…this is the reason why everyone is struggling with reflection, which contradicts this model because this has a six-step process with analysis at the end.* (Charlie-IV1)

What Charlie is saying here is that because 'analysis' appears to take place at the beginning of a critical thinking model that he learnt at school, and 'analysis' appears towards the latter half of the reflective cycle, he offers that the differing positions of 'analysis' within both these models of thinking indicate a contradiction between them. Charlie concludes by offering that the contradiction between these models is the reason why students struggle with reflection, implying an underlying confusion in the interpretation of both models.

4.4.3. Responses from the tutor interviews

Responses from tutor interviews were similar to those of students. However, a different perspective was offered by George:

> *I think it is purposeful, goal-orientated in terms of critical thinking and it's being reflective about your thinking whilst you're thinking. So, it is a way of reasoning with it as well. You're trying to make value judgments on your thinking. A goal relates to an outcome-based result and I think it's almost within the critical thinking process, is reflecting on your thinking whilst you're thinking, as it were.*

Here George states that the purpose of thinking is a goal or outcome. The purpose could lie in deciding what to do or believe. He further elaborates that the process of reasoning involves reflection on your thinking. This exemplifies the earlier point that reflection can take place during thinking. Reflection involves critical thinking, so what is being described as reflection during thinking could be 'thinking about their thinking.' According to an earlier description of metacognition, reflection during thinking is known as metacognition. George's statement is therefore similar to Jacob (IV3) where he (Jacob) asserted that critical thinking and reflection were 'parallels in thinking.' It appears possible that both thought processes could take place simultaneously.

4.4.4. Summary of findings in relation to the sub-theme, 'critical thinking as reflection and metacognition'

There were no comments relating to reflection in the students' first year of study. During the second and third year, students expressed a perceived link between critical thinking and reflection. Reflection has been described as past tense critical thinking, which involved the higher order skills of thinking, and was thought to occur in the latter portion of a typical

reflective cycle. Both thought processes were described as parallels in thinking where they appear to be inter-dependent.

Participants also suggested that reflection is always critical thinking. This reflective, critical thought process can take place during imaging examinations and can be called thinking-in-action or reflecting-in-action. It can also take place after the examination and can be called thinking-on-action or reflection-on-action. Students spoke of deliberating over their thoughts and actions long after the event, thus learning through self-awareness and reflexivity. Developing their self-awareness is indicative of their development of metacognition. Tutors, like students, spoke about the process of reflecting on thinking, as part of the critical thinking process. Reflection on thinking during thinking is metacognition.

Overall, responses from the second and third phase student interviews and the tutor interviews indicate that reflection often led to an outcome, which determined what action could be taken that may be different to the one taken before. They articulated that this could happen during the action (in action) and after the action (post action), sometimes long after the decision was made. Thinking about their thinking is metacognition and is an act of reflection. According to the participants, the process of reflection involved analysis and evaluation; these are the cognitive skills of critical thinking. Critical thinking was therefore seen as integral to reflection and metacognition.

4.5. Chapter summary

This chapter has addressed key findings in relation to my first research question: what is radiography students' and tutors' understanding of what is meant by the term 'critical thinking?'

During the first phase interviews, students attributed meaning to simple situations that required seemingly straightforward thinking processes. Their experience of university learning and clinical placement resulted in the development of their understanding of the meaning of critical thinking as they progressed through the programme. They learned to rationally and logically consider their inferences even though most of them had not developed the confidence or assertiveness to argue their inferences to the full extent in clinical practice.

During the second phase interviews students built on their understanding of the meaning of critical thinking from the evaluation of information, in decision-making, to problem-solving. They perceived the thinking process to involve breaking down of a problem with the evaluation of the component parts to help them solve a problem. They spoke about complex situations

where the decision-making process is not considered a straightforward situation. They linked examples to how they would think in various clinical situations. They indicated that they would weigh up their argument by careful consideration of criteria and felt better informed about the consequences of decisions made. They stated that they reflected on their decisions long after the decisions were made and used the outcome of their reflective thought processes to inform future decisions and actions. In building on their responses, following their first interview, therefore, students now understand that critical thinking is more than the analysis of information. It involves evaluation seen in solving a problem. The comparison of their responses (above) in relation to the analysis of information in the first year, to the evaluation of information in relation to problem-solving in their second year, indicates a growth in understanding of critical thinking from the first year to the second year.

During the third phase interviews, students indicated their development through being less inclined to be judgmental and more open to considering alternative options. They felt that their decision-making abilities were strongly influenced by empathy developed from working with patients in a clinical practice environment, as well as ethical and moral considerations in making the right choices for patients. Students demonstrated awareness of themselves through metacognition and self-regulation in relation to consequences of their thought process and subsequent decisions they made. There were no new themes emerging from the third year interviews revealing that the themes had consolidated. The third-year interviews, therefore, served to validate the findings in relation to participants' understanding of the meaning of critical thinking.

The study has evidenced that students were able to describe their understanding of critical thinking using words and explanations cited in published definitions from key authors in the field. However, contrary to the literature, the findings indicate that students do have some understanding of the meaning of critical thinking; this was evident from their interview responses. Over the course of the three interview phases, student participants grew in confidence and developed a broader sense of thinking. They also demonstrated an understanding of the consequences of their thought processes and decisions regarding the welfare of patients. Their responses informed me that they developed as student radiographers and their thinking skills had developed too.

From listening to tutor participants during the interviews it is clear they understand that different forms of thinking exist and that you would use different levels of thinking depending on what the situation or issue is. All tutors were able to describe what critical thinking meant to them in an eloquent and knowledgeable way. They felt the level of thinking applied to

situations would affect the quality of the decisions taken. They felt that critical thinking skills were important for practice as this influenced a radiographer's clinical reasoning abilities. In terms of the application of decision-making to clinical practice, all tutors were able to speak about the impact or consequences for not making the 'right' decision, and the need to ensure that ethical and moral considerations inform the decision-making process. Similar to students, the tutors spoke candidly about the serious consequences of decisions and the importance of critical thinking in rigorously evaluating their reasoning and thinking processes when decisions needed to be made.

In their responses, they broadly matched the students regarding the subthemes emerging from all interview phases in relation to this theme. They were able to articulate their understanding in a manner, which convinced me that they did know and understand what critical thinking meant, contrary to the position stated in the extant literature which suggests strongly that students do not know anything about critical thinking, and neither do the tutors. What is a mystery is how that learning is instilled in students by tutors? For example, there is no explicit teaching of critical thinking skills on the programme, so although they can demonstrate knowledge and understanding of the concept, the concept has not been explicitly taught in the university-based part of the radiography training programme.

Having summarised the findings of participants' understanding of the meaning of critical thinking, a discussion of subthemes in relation to participants' *development* of critical thinking is presented in Chapter Five.

Chapter Five

Findings in relation to participants' perceptions of how critical thinking develops over the three-year programme period

5.1. Introduction

In this chapter, the findings in relation to my second research question, "how do radiography students and tutors perceive the development of critical thinking skills," are presented. First, the data from student interview phases are presented followed by tutor interviews. Participants' verbatim responses are given in italics. The first interview phase was conducted prior to students' attendance at clinical placement. It was structured in this way to capture the students' views before they had experience of placement. In addition to not having attended clinical placement, students had limited experience of teaching and assessment at university. Their responses were, therefore, personal experiences of students who were new to the university.

During the second phase interviews, students' views on any change in their perception of how critical thinking developed and what factors influenced any change, were explored. Prior to the second phase interviews, students experienced a range of assessment at university and attended their first clinical placement. The responses from this interview set, therefore, deals with students' developing understanding and awareness of critical thinking, both in the context of their own personal critical thinking development and of their clinical placement experience and learning. Included in this interview schedule was a critical thinking exercise. The purpose of the exercise was to explore students' ability to use critical thinking skills using structured questions which were based on Halpern's (1989) and Facione's (1990) attributes and dispositions of critical thinking skills (See second phase student interview schedule in APPENDIX 12 and case study in Section 5.5, p. 134). They were invited to think of a real, recent scenario which could be related to their home, university or clinical placement experience. All students recalled an incident from clinical placement that involved interactions with patients and radiographers. The responses from this exercise are integrated within this section.

During the third phase interviews, student responses to any change in their perception of how critical thinking developed, and what factors influenced any change, were explored. Prior to the third phase interviews, students had experience of a much broader range of assessment

methods at university, different patient care case study scenarios, and a more complex radiography curriculum to support their development to a graduate practitioner. In addition, they attended longer clinical placements including elective placements and more advanced, specialist placements, including MRI (See p. x), cardiac and interventional radiography (See Glossary, p. xi). The responses from this interview set, therefore, dealt with their extensive experience of learning from both university and clinical placement.

There were three subthemes which emerged from this theme namely:

- Role of university and placement learning – translating theory to practice
- Development of knowledge and understanding from naïve to complex understanding
- Challenges in developing critical thinking skills

Figure 5 presents the relationship between the subthemes.
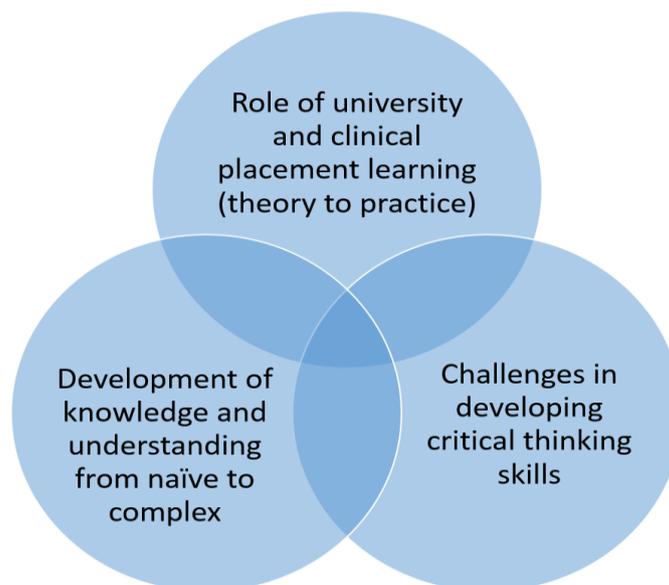
Figure 5. Visual illustration of the relationship between the subthemes in relation to the development of critical thinking.

Later, in the discussion chapter, I discuss how these subthemes interrelate and overlap

5.2. The role of university and clinical placement learning - translating theory into practice

This section focuses on participants' perception of how their application of learning from university and clinical placement was instrumental in their development of critical thinking.

5.2.1. Responses from the first phase student interviews

In response to the question, "how do you think critical thinking develops in radiography", six students felt that instructional strategies, for example, essay writing, helped to develop this skill at university. Two examples of responses are given below:

> *If I have to break down and argue the question and look at the key words and read around the words for what it means and how it is applied, only then does it start to make sense.* (Emily-IV1)

> *I would say in essays… where you can receive feedback. You can discuss your feedback with someone* (tutor or colleague). *In practice it is difficult to develop critical thinking skills in an exam because there is only one answer really that is correct. But in coursework assessment you can have an explanation of why you were wrong.* (Isla-IV1)

The description of breaking down a problem amounts to analysing information. Here Emily deeply considers the key words to answer the essay questions. For example, in preparing students to answer essay questions, they were advised to look at the questions and highlight the keywords to ensure that they do answer the question correctly. The keywords in the essay question might be: to describe the internal structure of bone. Emily stated that she would read around those words to get a good understanding of what the words mean so that she would be well prepared to write her assignment. She perceived that deconstructing complex statements ('break down and argue the question'), required in writing essay assignments, helped her make sense of the work. The academic skills guidance, provided at university, speaks about analysis and evaluation of information in relation to published work. This, therefore, provides students with the first opportunity for structuring their thinking at Level four (See Glossary, p. xi). The SEEC descriptors (See APPENDIX 2) gives clear guidance on academic expectation at Levels four, five and six. Furthermore, Isla makes the distinction between examination and coursework assessment, asserting that coursework provides a better opportunity to develop critical thinking skills as compared with exams. In addition, Harry (IV1) spoke about the case study learning in relation to developing critical thinking skills. Below is his explanation:

> *Certain case studies given in lessons helped me imagine a situation like that and then you can use critical thinking to learn what to do in that situation…*

He linked his experience of learning from case study activities, where he could imagine a situation based on that scenario. Case study learning was reported as a reliable method of learning by Paul and Elder (2007) which led to the development of critical thinking skills. The students therefore identify learning activities as being instrumental in the development of critical thinking skills.

Nine students felt that knowledge of radiography is required to develop critical thinking skills. At this stage of the course, students identified a link between radiography specific knowledge and the need to make decisions within diagnostic radiography. Two examples are given below:

> *I feel it* (critical thinking skills) *will become better with experience as I develop more knowledge. I don't feel you can make a decision without the knowledge and if you do it will not be a good decision.* (Sophie-IV1)

> *I think at first critical thinking is fairly limited because I have limited knowledge of radiography at the moment compared to three years' time. It is very limited as to what you can think about as you still need to learn. I think when I go on placement I will have a lot more experience to draw on and I will be able to do a lot more critical thinking. I think critical thinking will develop much quicker than learning from lectures.* (Harry-IV1)

Sophie's insightful comment is particularly important for radiography practice as decision-making is crucial to good patient outcomes (Edwards & Delaney, 2008). Clinical decisions require sound knowledge to justify them. This concurs with Bloom's (1956) taxonomy where knowledge forms the building block in the development of the cognitive domain (See Section 2.6, p. 35). Moreover, Harry anticipated that he would develop the skill much quicker in clinical placement as compared with university learning. This is an interesting perception considering that students were new to the programme and had not yet attended a placement at the time of this interview. In his statement, Harry implies a link between clinical placement learning and critical thinking skills development and considered that placement would provide 'new opportunities' to practice critical thinking.

5.2.2. Responses from the second phase student interviews

Findings revealed that all thirteen students felt the experience of learning at clinical placement enhanced their development of critical thinking skills. Two examples are given below:

> *… (Clinical placement) helped me develop the skills that allowed me to make an informed decision, based on what's around me and by taking information from the scenario and using past information and skills.* (Isabella-IV2)

> *…that you have to look at your surroundings, the situation first before forging ahead and doing the normal or routine thing. You treat every situation differently, and every patient and X-ray differently. Next time I will build on that experience.* (Olivia-IV2)

Clinical placement was found to have provided a platform for students to apply their knowledge gained in year one and develop skills to make informed decisions. The application of theoretical learning from university to clinical practice helped them in the development of the decision-making skills. In order to make a decision, students felt they need prior knowledge

and skills from university learning. Furthermore, by the statement 'every patient is different', and showing an understanding that every examination is different, there is acknowledgement that a patient is a person and not simply a 'number.' Each interaction requires more than just the routine application of thought. It requires deeper thinking, i.e. critical thinking, as previously discussed in Chapter Four. This demonstrates both affective dispositions and cognitive skills of critical thinking development.

Students were supervised during clinical placement by qualified radiographers. Ten of the thirteen students interviewed considered that working alongside radiographers was a significant factor in their learning development. Two examples are given below:

> *Yes, working with the radiographers especially with the CT (See p. x) superintendent helped to build my confidence. She was then telling other radiographers that they need to teach us and give us tasks, and this helped. As you do those tasks they then give you slightly more complex tasks and by the end of my placement, they were encouraging me to do all the CT scans. So, my interest in CT was nurtured as I had the support of the radiographers. There will always be a few radiographers that you are more likely to approach for help and you tend to go back to them whenever you need help. They are more approachable than others. They offered positive reinforcement by getting me to try harder.* (Olivia–IV2)

> *…the radiographers have taught me a wide range of things – some radiographers have their own way of doing things, and they tend to contrast at times – so it's best to take the good out of everyone and make your own way out of that, which I've learnt...*(Isabella-IV2)

Through positive reinforcement of learning, radiographers appeared to have influenced the development of critical thinking skills in the students they supervised. Olivia spoke about being given more challenging CT scans to perform as she got better at routine scans. CT imaging is a specialist imaging pathway which students learn in their second year of study. This development in Olivia's learning can be attributed to the scaffolding nature of knowledge development (Woods et al., 1976), where learning is constructed from one building block, in this case, a routine examination, to another building block, a more complex examination. The radiographers acted as the 'scaffold' to help develop Olivia's learning of routine scans. Once she grasped the practice of performing scans, they removed themselves as scaffolds so that she could perform these scans unsupported. She then moved on to more complex examinations and, at this point in her development, the support from radiographers returned, enabling her to develop further. However, the students have picked up good learning habits as well as poor practice, as evidenced in their responses. This is a challenge for both tutors and students alike. Students need to learn to listen to all radiographers, as well as, think for themselves. There is considerable acknowledgment here of the differences in how radiographers approach imaging examinations and the thinking that needs to take place in

deciding which approach to use. This again is an indication of thinking in practice and not merely repeating the habitual practice of others, in this case, the radiographers. Isabella demonstrated the beginning of discerning judgment which is a skill of a critical thinker, who according to Paul (1990), has a more disciplined thinking process which stems from having a critical thinking attitude as compared with that of an uncritical thinker (see Chapter Two).

Radiographers, however, appeared to be guided by students' own motivation and willingness to learn, as stated by Sophie (IV2) below:

> *…it was more my own motivation, my own willingness to learn and to throw myself into things and seeing who's there willing to help me. I think it comes from within the person if you want to learn, to see how far you want to go instead of getting people to guide you all the time. It's nice to know that the person is there if you need them, for advice, but it comes from within the person.*

Sophie's assertion that motivation 'comes from within the person' is an indication that she is developing one of the dispositions required of a critical thinker. However, from the extract above it is difficult to say whether this disposition was always there or had developed from the previous year (year one). As previously discussed a person can possess the skill of critical thinking, but critical thinking cannot be applied unless students possess the disposition towards using the skill (Halpern, 1989).

When asked whether their critical thinking skills had changed from the previous year, eight from the thirteen students interviewed admitted having observed changes in their thought processes, confidence levels and assertiveness in year two. Additionally, there are illustrations of how critical thinking developed within the clinical setting with students having gained experience in dealing with opposing views, discussion of decisions with supervising radiographers, and a sense of increased independence of thought: all against the backdrop of concern for the patient and in balancing the risk of radiation with the benefit of the examination. Two examples are given below:

> *…I would say when you are first given patient information and you have to work out whether you can or can't X-ray them, it is not straightforward and you kind of think, 'can you actually allow someone to be x-rayed?' Then we have to justify why the patient needs to be x-rayed and the radiographers would question you on this…It's one of those things that you go through in lectures, but you don't fully understand until you have to do it in the clinical environment. So, I think I have definitely got better at this.* (Harry-IV2)

> *I notice that I think more independently, and I am able to discuss my thoughts and decision with my mentor. For example, there was a little girl who came in with her arm in a collar and cuff. I had to X-ray her forearm, and I discussed ways to adapt the position her forearm that would give us a good image and*

one that would cause her the least pain and anxiety, and which could be taken quickly. (Jack-IV2)

Harry related his experience of development of critical thinking skills to the justification of an X-ray examination request. Justification of an X-ray examination involves the matching of a patient's clinical indications with the requested diagnostic examination and the desired information sought from the examination. It is a radiographer's responsibility to ensure that the requested information satisfies the justification of an X-ray examination, where the benefit to a patient outweighs the risk of receiving a dose of ionising radiation. Justification of an X-ray examination request requires the application of critical thinking skills and is the first task that students are given to exercise their reasoning and decision-making abilities, leading to the development of critical thinking skills. Students learn the theoretical aspects of justification at university and practice the application of this skill at placement. Whereas in their first year of study students have had the opportunity to justify the requests for X-ray examinations to their supervising radiographer, the final recommendation was made by the supervisor. In their second year of study, however, students were beginning to question the justification of examinations having gained more knowledge and experience. Also, Harry was able to acknowledge that his skills had 'definitely got better.' Jack demonstrated growth in his understanding of the need to make changes to the way in which he would habitually perform an examination to a more critical thinking approach. His reasons were clearly justified, and his action demonstrates growth in his confidence, assertiveness, independent thought and willingness to consider alternatives methods of positioning the patient: all dispositions of a critical thinker. By considering a way to adapt the position of the patient's forearm, to reduce their pain and anxiety, Jack demonstrated not just cognitive skills, but affective dispositions of critical thinking as well. He clearly demonstrated the development of his critical thinking skills from the previous year (year one).

One student mentioned how they perceived the development of critical thinking to have been influenced by remembering to think critically following their first interview. Below is Thomas's (IV2) explanation:

> *I think my actual skills have improved through practice of thinking things through a lot more. Since the interview last year, whenever I have to make a decision I think that I need to think about the decision more, like critically. I've been thinking well 'why am I thinking', 'what I am thinking', and 'what am I thinking about the decisions I have to make?' It's got me to take a step back and think through my decisions rather than be impulsive. It's starting to develop from this time last year.*

What Thomas describes above are his metacognitive thoughts, which reiterated the need to engage with critical thinking as part of the way it develops. See Section 4.4, p. 100 for a brief

discussion on metacognition. It is interesting that participation in the study reminded him of the need to think critically. This could have perceived to be because of the Hawthorne effect where research participants practice the skill they were questioned on and consequently become better at it. Raising awareness of critical thinking through participation in this study might have been the catalyst for this metacognition. From Thomas's statement, it appears that the interview acted as a prompt, to think deeper and reflect on their thinking process. However, the students were not asked to do this as part of the research study. Apart from Thomas, this view was not expressed by any of the remaining students. In addition, as a tutor to this cohort, I believe that the student participants were not further on in their development of critical thinking as compared with the rest of the cohort and therefore believe that Thomas' view does not weaken the ability to transfer the findings to other student groups outside the research group.

5.2.3. Responses from the third phase student interviews

Consolidation of emergent themes was evident in relation to students' views that feedback helped them in their development and learning at, both, university and placement. Two examples are given below:

> *Feedback from placement on my actions, attitudes, and contact with patients have been useful. In terms of university assignments, the feedback on my critical analysis has improved from year one to last year. I have been getting better marks. The theoretical feedback has helped me as a person as well.* (Chloe-IV3)

> *I had not done much with my feedback in the past because it was not written in a way I found useful. The points for improvement were not concrete. I used to get points for my critical analysis as I waffle a lot…a lot of fluff but I have improved over the years as those comments have also improved.* (Emily-IV3)

Students agree that feedback helped improve their assessments and placement performance over the study period. In addition, students found that feedback on their ability to critically analyse information improved over time, resulting in better assessment grades than in the previous year (year two). Students stated in earlier interviews that although critical thinking was not explicitly taught at the university there was an expectation that they would know what it is, coupled with the requirement to demonstrate this skill in assignments. This is evident in Emily's statement above. Chloe and Emily reported that feedback in relation to critical analysis, as seen in assignments improved in comparison with previous years. It is reasonable to deduce, therefore, that students were developing this skill even though it was not explicitly taught at university. As an insider, having an overview of their performance on the programme, there was evidence to suggest that students met the criteria for passing their

assessment, where critical analysis formed a highly weighted assessment criterion, implying that the skill was being developed, but implicitly rather than explicitly.

Similar to year two, all thirteen students found the learning at clinical placement to be instrumental in their development of critical thinking skills, thus consolidating findings in relation to this theme. Two examples are given below:

> *…placement helped a lot with building on the theory that we learned and applying it in practice. Example, when you have a patient who comes in for a CXR* (See p. x)*, then you would just do a PA* (See p. x) *chest. However, if you find something on the image then you can go to the radiographer and discuss the option of doing a lateral view. You will look at what else can be done for the best outcome for the patient.* (Thomas-IV3)

> *…giving a lot of opportunity for critical thinking as you have to justify your request by yourself. They (radiographers) allow you to critically think together where I have the chance to think my reasoning out aloud to them. We then discuss what it needed and why and then we weigh up what the options are and then decide on what action to take.* (Emily-IV3).

Here there is a good description of how theory, taught at university, comes together at the point of an application involving patients in clinical practice. When examining a real patient, there was the application of deeper thinking in deciding what else could be done for a patient regarding specific requirements, as mentioned above. This experience combined with university learning resulted in a higher level of knowledge and understanding. This is where the skills of critical thinking are practiced and developed. Placement learning provided them with practical hands-on experience in working with real patients. Some interactions presented complexities which they had to think about rather than going ahead in a routine manner like they did during practice sessions at the university. It was in those complex moments, through the application of their deeper thinking skills, that their learning really expanded, and development of their critical thinking skills occurred.

5.2.4. Responses from the tutor interviews

All five tutors felt that the opportunities for critical thinking skills development are provided at the university. Two examples are given below:

> *I think we help our students in this anyway. At Level six, the expectation is critical analysis and evaluation and we did lots of scenarios - ethical scenarios, night work scenarios using real examples asking them what will influence their decision etc. We do point out to the students that it is not just about arriving at a decision, it is also about how you make that decision, what are your thought processes, what thoughts guided your thinking and how did you reach the decision. It's also about giving the students the tools to think and to decide*

when to go for help when you are faced with situations that are outside your scope of normal practice. (Mia)

As long as we encourage them in the way we teach, and the activities that we do – we don't just do didactic teaching, we ask them to discuss things in detail and see what they think about it. As part of our teaching and self-directed study, we give them activities to prompt their thinking in the right way, and I think we should do that from day one. (Sophia)

From these extracts, it is clear that demonstration of critical thinking skills is expected as students proceed and progress through the programme. Importance is drawn to the process of making a decision rather than simply arriving at the decision. Furthermore, Grace asserted that although learning and teaching activities for critical thinking skills development are offered on the programme, the link between the learning activity and critical thinking skills development are not explicitly stated, as mentioned below:

…we do not tell students that if you do this activity then these are the skills you will be developing. (Grace)

As a tutor, links with teaching and learning exercises and the skills they develop are not currently clear to students and could be a reason why students do not make the connection between learning activities and critical thinking skills development.

However, George offers a disparate view as stated below:

There is a challenge in that we are faced with a growing Google generation – you can get what you want when you want to. There's no need actually to think originally for yourself.

In George's view, students are 'spoilt' by having access to masses of information on the internet where answers can be sought by quick searches. These actions are perceived as removing the need for students to think for themselves in their quest for instant gratification. In my experience, this has made students less likely to think for themselves. In addition, it has created a challenge for tutors to engage students in their learning, and to be able to sustain that engagement.

5.2.5. Summary of findings in relation to the role of university and placement learning

In this section, a summary of the findings in relation to the above-mentioned subtheme are presented. In year one, students were new to the university and to diagnostic radiography education and training. The contact was largely instructional. There was therefore not much scope for practicing the skills for critical thinking and being able to discuss different approaches to radiographic examinations. It is evident that most students do not know how critical thinking develops at Level four but perceived that writing university assignments and

learning from feedback to be conducive in their development of thinking skills. There was a consensus among students that knowledge and experience were pre-requisites to developing critical thinking skills. This is discussed in more detail in Chapter Six. In addition, students perceived that clinical placement would provide more opportunities to develop critical thinking skills.

In year two, students recognised that the mentorship, feedback, and reassurance received from radiographers positively influenced their development of critical thinking skills. The students demonstrated their ability to think logically and critically from the evidence and were able to draw reasonable reasons to support their decisions or choices. In their reasoning process, they demonstrated the use of critical thinking skills from year one to year two. This was seen in their ability to justify the X-ray examination requests, which at Level five would have been in relation to more complex examinations in comparison with year one. They were required to verbally explain their thought processes. They acknowledged that their attitude to learning was changing which signified development and growth in both knowledge and confidence.

In year three, students acknowledged that feedback in relation to critical thought and analysis in written assignments had improved over the three-year period. Some perceived their specific feedback on critical thinking abilities to have improved resulting in better marks. The role of clinical placement was seen to be instrumental in consolidating their learning through experience gained. There was a higher level of articulation observed within their responses with more complex examples discussed as compared with their year two responses indicating the development of skills and attributes of critical thinking.

Like students, tutors agreed that clinical placement experience is crucial in closing the theory to practice gap and has a fundamental impact on student learning. Tutors felt that scenario-based learning activities offered on the programme facilitated the development of critical thinking skills. However, they felt that teaching and learning exercises on the programme were not explicitly aligned to developing students' critical thinking abilities.

5.3. Development of knowledge and understanding from naïve to complex understanding

This section focuses on participants' responses to how they perceived the development of increasingly complex knowledge and understanding through the radiography programme.

There were no responses from the first-year interviews that contributed to this theme. A likely explanation for this is that students had limited experience of learning at university and had not attended a clinical placement at the time the interviews were conducted. This theme emerged during the analysis of the second-year student interviews and consolidated following the third-year interviews. The student responses are presented followed by the tutor interviews.

5.3.1. Responses from the second phase student interviews

In response to the question, "do you think your critical thinking skills have developed from last year" seven out of thirteen students indicated that they did not feel their critical thinking skills had changed. However, the remaining six expressed a change. Two examples are given below:

> *Definitely. I had quite a few little glimpses in various departments when after something had happened, I would think well actually… you can actually do this. I am more self-confident than last year. Now I am more likely inclined to compare what other people say and trust my own thinking.* (Olivia-IV2)

> *It has…you are questioned* (by radiographers) *on the spot regarding justifying requests. Justification is a big thing and that makes you think. You get better and quicker at it the more you do it.* (Harry-IV2)

Olivia spoke of confidence and assertiveness to think independently, both of which are dispositions of critical thinking. These changes in her experience indicated that critical thinking had developed from her previous year (year one). Similarly, in Harry's example, analysing and evaluating patient information on the X-ray request cards led to faster, justifiable decision-making. He demonstrated, through his articulation above, that his critical thinking skills had developed from the previous year. The students felt adept at trusting own judgment and had the realisation that they were thinking more deeply and broadly.

Interestingly, Charlie (IV2) already considered he is a critical thinker as stated below:

> *I would say, the knowledge I've gained on clinical, has definitely helped apply my critical thinking in a radiography context. As for actually developing my critical thinking, I'm pretty sure the mechanisms were already there, and I'm just filling in the blanks of my knowledge, and then using the critical thinking that I already had.*

Charlie, therefore, asserts that he already possessed the skills of critical thinking and that the clinical placement environment allowed the opportunity to gain knowledge and apply those skills. Charlie already has a first degree and it is possible that he developed critical thinking skills as a transferable skill, stemming from his previous degree.

Six students were able to clearly articulate examples from practice where they demonstrated their critical thinking development from their previous year. Olivia (IV2) describes her experience below:

> *I was working in A&E and a patient in Resus needed a chest X-ray. If I sat her up completely she wouldn't be able to breathe and if she lay down completely she wouldn't be able to breathe either. And she was getting very upset and flustered. So, I had calmed her down and worked out what the best method for doing the X-ray was; then the radiographer had come in and he just like took the back of the trolley and just sat her up. She started crying and was very upset. She didn't want the radiographer anywhere near her because of that. She said that she would only agree to the X-ray if 'Olivia' is the one that does it. No one else. So, it is having those patients, even though you have only been with them for about 15 minutes. It's those moments when you feel that I can do this, and it works.* (Oliva-IV2)

In addition, Olivia (IV2) elaborated further as presented below:

> *…she (the patient) already told us that she was unable to breathe in these two positions and we know that from the start. We just needed to slowly move the back of the trolley, backward and forward to a position which she felt comfortable in. So, it was important to take that into account when positioning her. She was lying on her side on the trolley when she came in and when we spoke to her about how we would like to position her to get a good image, she straightaway said that she couldn't sit up like that. So, we had to use her as the guide to help us position her in such a way that she felt able to sit for the X-ray and to be able to breathe… You have to think a bit harder when the obvious does not work.*

Olivia, in her description of her application of critical thinking skills, relates to a more complex patient scenario compared to examples given by students in year one. In year one, students will have gained experience in examining patients who were ambulant, and the examinations would have been routine examinations. Here during her second year, she is undertaking more complex radiographic examinations on more complex patients, indicating a progression in her knowledge and understanding as a student radiographer from the first year to the second year. Her reasoning skills are clearly articulated as is the ability to consider options regarding the comfort and safety of the patient. There is, therefore, a clear application of Olivia's cognitive skills and affective dispositions of critical thinking. Managing a more complex patient than she did in her first year of study and managing the additional difficulties that arise during the examination, as in Olivia's case, indicates growth and development from a naïve understanding in year one to a more complex understanding in year two.

5.3.2. Responses from the third phase student interviews

Findings from this interview set revealed that although four students perceived their development of critical thinking to have remained the same from the previous year, the rest perceived their development of critical thinking to have changed in their third year of study. Two examples are given below:

> *I think it is a lot better than it was. I found year two harder than year one. There was more responsibility, especially for placement. I feel that my thinking is more structured than in year one, especially in terms of image evaluation. I do still link together information and break down information so that I can understand what I am doing.* (Lola-IV3)

> *Yes, it definitely has. Before I would take other peoples' opinions. Now I think through things myself. I will evaluate things myself first and then check with others if that will work and then I will go with that. Moving from consensus thinking to independent thinking. University has helped a lot as we are required to think about things in different contexts.* (Sophie-IV3)

Lola acknowledged that her thought process had become 'more structured' compared to years one and two, and relates her view to image evaluation, which is a key competency in the practice of diagnostic imaging. Image evaluation requires the methodical, visual processing of an image in relation to several criteria, e.g. image quality, accuracy in positioning of a patient, inclusion of the entire area of interest, radiation safety measures and so on. Sophie perceived her development as a change, from previous consensus seeking to one of independent thought and decision-making. This is an important step in the development of autonomy and using her judgment. Decision-making and trusting one's own judgment are dispositions of critical thinking. Students have demonstrated that they are developing the skills and dispositions of critical thinking as described by Bloom (1956), Halpern (1989), and Facione (1990).

Four students spoke of the learning gained from the task of prioritising patient examinations. Two examples are given below:

> *…that was hard for me. This forced me to think deeper and make the connection and be able to justify why I am doing things in a certain way especially in organising patient lists. Confidence is important to be able to stand up to being interrogated or questioned in that way. As a student, you have to be open to this kind of challenge as it has been a really good learning experience.* (Jacob–IV3)

> *…I evaluate things for myself first, then check with the radiographers if it will work, and then I will go with that. This helped me enormously in prioritising patient lists as I will have to do this by myself as a qualified* (radiographer)*…* (Sophie-IV3)

Here is the demonstration of thinking to justify X-ray examination requests, by Jacob, where he was required to justify the order of priority in which he would examine the patients. Each patient request needs reasoning to justify its need in relation to the examination. Similarly, Sophie explained that she became increasingly independent in her decision-making. However, she conferred with radiographers to act as a sounding board to her decisions, acknowledging that this part of her development was crucial to autonomous decision-making in the future. Sophie, therefore, identified that as graduate practitioners, they will have to do this autonomously. It is evident that radiographers contributed to their development of critical thinking abilities required in the prioritising of examination lists. Prioritisation of patient examinations is a Level six competency and this task requires the use of higher order thinking skills of analysis, evaluation, and synthesis, in justifying the order in which patients are examined. This extract demonstrated their development from year one (novice) to year three (expert student radiographers).

Eleven students spoke of a growth in relation to the level of thinking required in undertaking a simple task or routine examination, compared with a complex task or new situation. Two examples are given below:

> *I use an order in which I think through certain things like reading an X-ray requests. Some are quite simple, and I find that my order of considering the key components works well. For complex tasks, I will break down the components into smaller chunks and consider them in a more focused way.* (Lola-IV3)

Similarly, Harry (IV3) stated the following:

> *Simple tasks will bypass a lot of critical thinking. You would do a lot of thinking of simple tasks on a daily basis. With more complex tasks, like a complex procedure in theatre, for example, positioning the machine* (C-arm fluoroscopy unit, see Glossary, p. xi) *in the theatre would require more critical thinking to ensure I am positioning the tube in the right place. I would slow down a bit and think through what I am doing and what the consequences are. For example, in the case of the tube, if I place the tube incorrectly then the surgeon would not be able to see the images on the screen.*

In these examples, both Lola and Harry explained that during simple situations, they resorted to methods used in the past which were informed by their actions and experience, i.e. they would be working at a more routine or automatic level. However, in complex situations, both students acknowledged that they returned to a structured way of thinking where they considered all available information, processed the information using their critical thinking abilities and made decisions based on their evaluation of information. Lola said that her 'order of considering key components works well' for simple tasks, however for complex tasks she had to consider the components in a 'more focused way'. The words 'more focused' could be

perceived as a deeper thought process. She makes the distinction between 'simple thinking' and thinking in a 'more focused way,' which she understands to be different to 'simple thinking.'

Similarly, Harry states that complex tasks would 'require more critical thinking.' He related his understanding to the positioning of the fluoroscopic imaging equipment being used in the operating theatre. During this procedure, the student needs to consider multiple factors, such as the sterile nature of the environment, the position of the imaging equipment, radiation protection for staff and the patient, and the range of movement required for the imaging in relation to other equipment present in the theatre at the time. Careful thinking and planning of these multiple facets are required in this situation to successfully carry out the examination. Harry demonstrated his critical thinking ability within the complexity that this procedure demanded.

5.3.3. Responses from the tutor interviews

Findings from interviews with tutors revealed that they perceived the growth of critical thinking skills to take place gradually from year one to year three. Three examples are given below:

> *In year one, we do very little in critical thinking. They are overwhelmed with getting to University and learning the basics to go to placement. I think at the very beginning we give them the tools for critical thinking to e.g. evaluate their images against set criteria and decide whether to accept or repeat their image and get them to think about applying their knowledge at that stage. It is low level at this stage, but I think it is a critical thinking skill. I don't think they will get the notion of critical thinking in year one but certainly, they do start thinking and applying their knowledge.* (Grace)

> *Students need to get from novice to expert. We aim to develop their reasoning abilities and decision-making processes in relation to clinical situations.* (They) *need to learn about and understand consequences, how we can benefit the patient. Students need to continually assess the validity of what they do to solve clinical problems by seeing situations, both positive and negative, unfold on placement. They must learn* (knowledge)*, think and be aware of their thinking.* (They) *must learn to question, probe, give careful thought to clinical practice.* (Mia)

> *...midway through year two they then start to get in a jumble because they are flooded with information and they are then starting to find their own patterns, systems of work, own expectations, and that's when you get a classic comment of questioning their own learning and doing things differently. They start to challenge the practice they see in placement although this is seen more in year three as they learn more. Remember we are also encouraging them to ask questions and challenge what they see. Questioning is a sign that their critical thinking skills are developing but this depends on their motivation. They go through a steep learning curve in their final year. It's about what makes them motivated.* (Ruby)

Grace relates her explanation to the criteria given to students to teach them how to structure their evaluation of an X-ray image. She calls it "low level" critical thinking at Level four and although she feels that students do start thinking and applying their knowledge, she believes that students will not fully grasp critical thinking at this stage of their learning journey. Demonstration of critical thought is an assessment criterion at both Level five and six. Grace is therefore correct in her understanding of critical thinking development at Level four. Similarly, Mia feels that students must progress from a novice in year one, to expert students in year three. In addition, she feels that situations in clinical placement can be positive and negative; 'assessing the validity' of information therefore requires the application of critical thinking skills. Ruby explains that students begin to develop their own way of adapting radiographic procedures and begin to question and challenge poor practice as they reach the point of qualification, in their third year. Critical thinking can be developed by training the mind to think in a disciplined way (Paul, 1990): this is the goal of critical thinking. A disciplined way of thinking uses a system of thinking that includes asking oneself a number of pertinent questions. This can be likened to the Socratic philosophy whereby the goal of Socratic questioning was to question your thinking in a certain context or situation (Paul & Elder, 2007), such as diagnostic radiography. Adapting their radiographic technique and having the confidence and assertiveness to challenge poor practice requires critical thinking skills. However, Ruby elaborates that the application of students' critical thinking skills depended on their motivation and the factors which influenced their motivation. As previously mentioned, confidence, assertiveness, and motivation are dispositions of a critical thinker. However, it is possible that a student radiographer would possess the dispositions of a critical thinker but choose not to think critically, as discussed in Chapter Two. Ruby, therefore, makes the justifiable point that critical thinking skills development is dependent to some extent on student motivation.

5.3.4. Summary in relation to development of knowledge and understanding from naïve to complex understanding

In the first year of the students' journey, they were new to university study with no clinical placement experience. When they attended clinical placement, they were directly supervised by clinical mentors in accordance with the clinical placement regulations. During their second year of study, students grew in confidence and developed a broader sense of thinking. They understood the consequences of their thought processes and subsequent decisions regarding the welfare of the patient. They gained more knowledge and experience and were able to perform more complex examinations with less direct supervision as compared with the year before, leading to an increased level of confidence. They perceived that when something had

worked well in the past, they could repeat the action without the need to think critically about it. This demonstrated their learning from novices in year one to building knowledge in year two. Most perceived their development of critical thinking from year one to year two to take the form of being more decisive and self-reliant leading to independent decisions. During placement learning, the complexity of tasks helped to develop critical thinking further. Progress was observed by participants regarding the level of thinking required for conducting simple tasks as compared with complex tasks. Some students said their ability to make decisions became quicker from the experience gained working with patients. Students found that thinking through situations in clinical placement was not straightforward as there were many facets to consider during the thinking process. They demonstrated the development of skills and dispositions of critical thinking from year one to year two.

In their third year of study, their confidence continued to grow, and students undertook more challenging procedures having gained more knowledge and clinical experience, with less supervision as compared with their second year. They were also challenged in their learning by working as 'semi-qualified' radiographers where work patterns were matched with those of radiographers to prepare them for graduate autonomous practice. They were clearly able to distinguish between the levels of thinking required in undertaking simple tasks compared with more complex tasks. They understood the moral consequences of their decisions and demonstrated changes in their attitude towards decision-making. The findings from the third-year interviews revealed that the skills and dispositions of critical thinking were consolidating.

Tutors felt that the tools for critical thinking development are provided to students from Level four even though it is recognised that assessment of critical thought is not an outcome at this stage of learning. Tutors felt that students are encouraged to question information at university and challenge poor practice in placement. The skills of questioning were perceived to help them develop the skills of critical thinking. Furthermore, students undergo a steep learning curve during their second and third year of study, during which time there is significant growth in knowledge and experience as seen from novice to expert student development.

5.4. Challenges in developing critical thinking skills

Some of the challenges that participants felt affected the development of critical thinking skills on the diagnostic radiography programme, are presented in this section. This theme emerged during the analysis of second-year interview data and consolidated during the analysis of third-year interview data, during which the key messages were reproduced and highlighted. Students' perceptions of challenges are presented followed by tutor responses.

5.4.1. Student responses in relation to the challenges experienced in developing critical thinking skills

Students felt that university sessions did not explicitly focus on critical thinking skills development. Two examples are given below:

> *We were never given tasks at the university where we were told that this is critical thinking. We don't think about this, so we don't know if we are building critical thinking or not and it's not something that jumps to mind when you are given a task to do.* (Olivia-IV2)

> *All the teaching sessions helped. Interaction with staff helped but there were no sessions that focused solely on critical thinking per se, but just talking through with staff, clarifying things helped a lot.* (Thomas-IV2).

As was the case with tutors, students felt that links with learning and teaching activities and critical thinking skills development at the university were not made explicit to them. This poses a pedagogical implication for the programme and are confirmed in these views.

In relation to learning from feedback, nine out of thirteen students believed feedback did not always favour their learning. Two examples are given below:

> *…I have not done much with my feedback because it was not written in a way I found useful. The points for improvement were in my critical analysis…I didn't really get what they meant by critical analysis at the time.* (Isabella-IV3)

> *I think feedback in the department depends very much on who you are working with. The mentor has a big influence on your thinking and learning in placement. Sometimes the way feedback is given comes across negative and this can knock your confidence.* (Olivia-IV3)

In her example above, Isabella explains that she did not act on her feedback because she felt she did not know how to, especially in relation to comments on critical analysis. In addition, Olivia offered that the quality of feedback from clinical placement depended on how a radiographer presented the feedback. She asserted that feedback given in a negative way could impact on students' confidence, and adversely affect their learning and development at clinical placement. This implies that even constructive feedback comments can be given in a positive manner, and the overall manner in which feedback is given to students is seen as a direct indicator of student confidence, as stated by Olivia.

Eleven out of thirteen students experienced challenges in working alongside radiographers which affected their ability to develop critical thinking skills at clinical placement. Two examples are given below:

> *You can have your say, but then you can't really because you're just a student and it's kind of a power thing at the end of the day. It shouldn't be like that because everybody should be playing their part as a team. But obviously what the person in charge is thinking is that you haven't had as much experience as he has. What I learned in university about radiation safety, I thought would be correct to use in that situation – it's frustrating…but I could not…* (Jack-IV2)

> *…being robbed of the opportunity to think and make decisions.* (Olivia-IV2)

Jack felt that there is power wielded in favour of the radiographers, which inhibits the students in voicing their concerns even during times where poor practice is seen. He found the inability to practically apply his learning. It is not uncommon in practice today for radiographers to expect students to do as they are told. This reflects the traditional practice of radiography which was instruction led. Lastly, Olivia's sentiment of 'feeling robbed of the opportunity to think and make decisions,' speaks to a key challenge faced by student radiographers in the clinical environment today, where they are training for best practice, yet feel that they cannot question the actions or instructions of radiographers. It is true, therefore, that there may be limited scope for critical thinking development and development of the decision-making process, which may have an impact on critical thinking skills development and on learning in years two and three. It is best practice that inspires public trust in our profession, and student radiographers need to be considered as agents of change to ensure that best practice, that benefits the patient, is the order of the day.

Thus far, there is evidence to suggest that students are not being encouraged to explicitly develop critical thinking and that traditional radiographer practice can inhibit the development of critical thinking skills in students. Below are two disparate views regarding students' unwillingness to take initiative in their learning:

> *I'm sure that there are many people who are falling down on the 'critical analysis' aspect - so they should look at their feedback and reflect on how they can improve next time. In many ways, this is one of the key points from university - this isn't about simply regurgitating knowledge but showing that you understand and can appraise information. If you follow this practice, your marks should improve over time, but for some people, it would need to be a conscious effort whereas I feel that it comes more naturally for others.* (Amelia-IV3).

> *…this is going to sound harsh, but I think that many don't want to think. My view here is that the "thinkers" would simply take that point on board and recognise that we are "reading" for a degree and not being spoon-fed the answers (we've been told this often enough) so go away and work out how to do it. I think that this instance showed that many students on our course do want their hands held all the way… without having to do too much thinking of their own.* (Jacob-IV3)

Amelia and Jacob provided an appreciation of feedback as a valuable tool, which is seen to bring about improvement, however, at the same time acknowledging that some students do

not see this value and preferred to be 'spoon-fed.' Amelia makes the crucial point that learning was not about 'regurgitating' information but about demonstrating an understanding of learning in an appropriate way. Learning from feedback on assignments is considered one such way to improve your critical analysis. She states that while some students needed to make conscious efforts to do this, it occurs naturally for others. This implies that for students who are motivated to learn, this will be a natural part of the process whereas others will need to make an effort. Jacob feels that fellow students should have become better at independent learning, which is the culture of higher education, but he feels that many have not. This underscores that students generally do not understand well enough what critical thinking is and a large proportion are unwilling to take up challenges to gather information. At university, some students are passive absorbers of information, who rely on external stimuli for motivation and engagement with their learning. As a tutor, my view is that this could be the reason many students struggle with developing critical thinking skills at university.

5.4.2. Tutor responses in relation to the challenges experienced in developing students' critical thinking skills

Similar to the students, tutors acknowledged that teaching and learning activities had not been explicitly linked with skills they were designed to develop. Ruby's explanation is presented below:

> *I think we do offer suitable learning activities, but I don't think we, necessarily, label it as such. And I think if anything, there's more need at the moment for critical thinking abilities because of the uncertainty of the world we're in, and the healthcare environments that we're working within. Because of Google, if you don't know something you can 'Google' it – you don't actually have to think about it, and you're probably going to take whatever you find at face value, which I think can be dangerous. I think there's a need to develop critical thinking abilities so that you can actually assess the information that you're getting, rather than not thinking about it and taking it at face value…* (Ruby)

Ruby agrees that instructional strategies are not linked with the component skills that they are designed to develop, as identified in the previous section. However, she implies that students are impatient and are perceived to want instant gratification. The profession they have entered into requires the engagement of their thinking as a process, which does not always result in a quick decision.

Tutors felt that when students come to university they are not fully prepared for study at university level. Two examples are given below:

> *… the impression I get from school is that they're being taught to pass exams, and if you're being taught to pass exams, you're being given information and then you're practicing until you pass, and that doesn't actually allow people to*

think. So perhaps we need to look at, towards the end of the first year, putting in more thinking exercises, or decision-making exercises, to bridge that gap. What we're seeing now is that we've got an increasingly dependent student culture. (Mia)

... I think in radiography, firstly, what we have to do is we have to get our students to think, when they come through from A-Levels they appear to be spoon-fed. So, I think when they get here they are expecting the same… I don't think you could teach someone how to think critically. (Sophia)

Both Mia and Sophia feel that there is scope to offer a greater range of critical thinking exercises throughout the programme. Sophia's comment about not being able to teach someone how to think critically is an interesting one. Some students enter the programme with transferable skills. These are skills that they have already developed from other studies or jobs (as seen in Charlie's responses from IV2 and IV3), to help them develop further throughout their lives. As tutors, we can use these skills as building blocks to help develop their thinking processes. As Dewey (1933) says, we cannot teach people to think but we can help by giving them the tools needed to think, in a structured way. Regarding feedback comments, Sophia said that increasingly feedback on coursework focuses on the levels of critical analysis:

That is a huge part of the marking criteria especially at Level 6 when we are asking them to critically analyse and evaluate. Often students are very good at describing what they have done or what they have read but then they don't give any interpretation of it at all, e.g. what it may mean? Or what actually was said or what was the quality of the work?
Over the years I would say about 50% of comments on student feedback centered on the level of critical analysis.

This extract demonstrates the expectation of the development of critical thinking skills as a key skill in higher education. Sophia's comment indicates that feedback comments on the level of critical analysis are still prevalent on written assignments, implying that even at Level six, student writing appears largely descriptive and lacking in critical analysis. This is already a major pedagogical implication for the radiography programme. However, Ruby felt that there are additional implications in terms of how tutors teach and what they consider as a priority for their teaching:

…I think the fact that it's so implied in the curriculum means that it could get missed. But then the students that are good and aware of critical thinking will be doing so regardless of whether we teach it or not; then I would say that it doesn't matter that it's not in the curriculum because the good students will do it.

As tutors, we need to consider all students and not simply those considered as 'good students.' It is not good enough that we, as tutors, accept that it is implicit within the curriculum, yet we explicitly assess it.

Tutors agree that learning and teaching activities that enrich the making and structure of arguments are offered on the programme. It is a challenge to measure the impact of those activities to gauge if critical thinking skills have indeed improved or not. Below are George's feelings about this:

> *...that's where it gets hard. How can you actually measure something like thinking? I know that there are tools out there. But how do you measure something which is so subjective because it is hard to actually quantify it?*

Simpson and Courtney (2002) state that the critical thinking test instruments are generic rather than discipline-specific and because the umbrella term of critical thinking encompasses a very broad range of definitions one would choose the test that best matches the definition one believes to be appropriate to the setting. Thus, it would appear that tutors are measuring something different, but they call it critical thinking measurements (Cise et al., 2004). There are critical thinking test tools, but they have proved to be unreliable (Cise et al., 2004). For a result to be considered as valid, the result must be measurable and consistent over time, and applicable to a variety of settings. If the test scores do not satisfy these criteria, then it is considered to be subjective. George's understanding is therefore justified.

Tutors feel that teaching for critical thinking skills development is challenging. Two examples are given below:

> *…I think it is difficult to teach critical thinking; it's really hard, to teach it or to be able to recognise it for what it is…we have to also bear in mind as much as we don't like to admit it, some staff also struggle with instructions and too much information. As module leader, I have to explain some things in different ways in order for staff to understand. So, if they don't get it how are they going to explain to students?* (George)

> *… if they* (tutors) *don't understand it, the students are not going to understand it.* (Sophia)

One of the reasons critical thinking is found to be difficult to develop is because tutors perceive it as being a difficult subject to teach. It is a skill that develops through practice as seen through students' articulation of their learning experiences. George makes the point that this is a key challenge for tutors. Sophia said that one of the biggest issues experienced was in relation to fellow tutors, for example, where tutors were uncertain regarding their requirements once they were given a set of instructions on marking assessment. This clearly presents a pedagogic implication for the programme.

Some tutors emphasised that there are consequences when action and decisions go wrong hence the need for critical thinking in radiography. This is especially important as practice has

evolved over time from an instruction led profession to an autonomous one. Mia explained this below:

> *…the profession has changed so much. There wasn't much thinking involved, or autonomy or accountability. Now we've got an increasingly intelligent public who know their rights, and they wouldn't think twice about questioning us. So, it is important for us, then, to be thinking critically about what we're doing. Critical thinking allows for autonomy and not just doing what you have been asked to do. Some radiographers do this very well, but some don't, and our students see both sides of this kind of practice. Unfortunately, good role modeling is a crucial issue out there. We are not part of their placement learning, but we do not want our students to be radiographers who simply press buttons…they need to be the kind of radiographers that radiologists ask for because they know they will have the answer to their questions…without critical thinking, clinical practice becomes a technical operation…*
> *This will create thoughtful, caring, analytical and reflective students. It will also make them aware of their critical thinking, so it is not muddled daydreaming but purposeful and planned thinking.* (Mia)

> *…They* (students) *have to know so many more things now and we are expecting this high academic level of discussion coupled with the fact that we constantly have to react to the NSS* (National Student Survey*) and work our socks off to meet student expectations…they are now autonomous practitioners, who are now part of decision-making teams. We didn't have any autonomy when I was a student, we did as we were told.* (Ruby)

Mia's statement summed up the rapid advances within the professions in the last twenty years. From practitioners who followed didactic instructions without questioning, to the current need for questioning and making decisions autonomously is a big leap for the profession. Developing critical thinking, as part of their learning on an undergraduate programme, is crucial to professional clinical practice. One of the main reasons for this is that the nature of practice within the NHS is changing. Some graduates may go directly into Band Six jobs (See Glossary, p. xi), for example, mammography, where they will be required to make important decisions and to practice at that level of expectation. The NSS is a key consideration at the institution in which I work. As a tutor, it is fair to say that much of our efforts go into providing an equitable student experience rather than a pedagogical focus on developing learners. The overall landscape of education and practice reflects how our profession has changed through evolution, i.e. a theoretical evolution versus vocational evolution. These challenges present pedagogic implications for the radiography programme.

5.4.3. Summary of findings in relation to the challenges in developing critical thinking skills

In this section, a summary of findings in relation to the above-mentioned subtheme is presented. Responses revealed that although there are teaching and learning activities which are perceived to develop critical thinking skills in students, they were not overtly taught at university.

Even though students see a growth in critical thinking through experience during clinical placements their coursework grades and feedback comments still appear to have the same assessment of a lack of critical analysis as before. The data indicate that students do not understand what critical thinking means in their university course assessment. The data also indicate that although tutors were able to explain their own understanding of critical thinking, some struggle to explain the meaning of the term to students. In addition, tutors struggle to explain the requirements for critical analysis in students' university assignments. Feedback to students continues to include a large focus on the level of criticality where it is felt that assessments are still being marked as being very descriptive at Levels five and six, despite students having clear guidelines about the level of critical analysis required in academic writing at those levels of study. Many students were perceived as wanting to simply follow instructions rather than think for themselves. However, tutors also felt that, much like the students, some tutors required considerable support before they understood what was required of them. They thought that if tutors were not being critical thinkers themselves, then this may affect how students are given instructions and guidance. This is, therefore, a key consideration and implication for radiographic pedagogy.

In learning to frame their thought processes and coherently organise their arguments and decision-making, students encountered challenges within the clinical environment which highlighted the difficulties of making a decision in the real world where there is a difference in opinion between the student and the qualified radiographer. Students were clearly concerned with the moral and ethical dimension of the decision made and outcome for the patient. Tutors agreed that critical thinking is a difficult skill to develop and were able to speak about the consequences of not making the right decision. They felt that certain institutional pressures within our roles impact seriously on our teaching and assessment processes, for example, to improve NSS scores. Tutors felt that the student expectation of a good university experience has shifted the learning responsibility from student to tutor, resulting in increased student dependency rather than an independent learning culture. The dependency is seen by students who demand more and more study information. Some reports of students and tutors allude to this as 'spoon-feeding.' This could be a reason why students struggle with the academic requirements of the course as compared with their clinical placement performance.

5.5. A case study demonstrating the developing understanding of the meaning of critical thinking

5.5.1. Synopsis

The purpose of a case study is to demonstrate Amelia's learning journey from her first to the third year of study in diagnostic radiography. It is written as a longitudinal narrative to understand her development in relation to her experience, being a non-traditional university student. Amelia, in comparison with other participants, held many jobs for nine collective years before beginning her study in diagnostic radiography. One of her jobs involved working as a receptionist in a radiology department. Following this, she began work as a radiology department assistant (RDA) and worked in this capacity for six years. During her time as an RDA, Amelia's interest in radiography grew and she contemplated studying for an assistant practitioner position but was unsure. She stated the following:

> *…if I am going to do the whole university thing then I'd rather go and be a fully qualified radiographer rather than an assistant practitioner…*

The use of this single case study draws together the themes and concepts that have emerged from the data in relation to participants' understanding of the meaning of critical thinking and their perceptions of how critical thinking develops through a programme of study.

5.5.2. Findings

At the beginning of her first year of study, Amelia experienced a lack of confidence in academic work. She had not completed A-Level study at school and felt unprepared for study at university. She said that she *"felt confident in her previous job but felt completely out of my depth with academic study."* However, she recognised she had to work on her academic skills. Coming to university following paid employment was a big step for her. Her decision to attend a full-time degree programme, therefore, was based on her motivation to train to practice as a qualified radiographer. Amelia stated the following:

> *…employers are looking for people who are more educated…I didn't want to get left behind…stuck in a particular job earning a certain kind of money…*

In making her decision, she said she weighed the influencing factors of getting a university degree against the conflicting option of continuing with the paid employment she had at the time. She felt she used sound reasons in her decision-making process and considered her decision as *, "honestly… the best decision I have ever made."*

In relation to handling information on a daily basis, Amelia would rely on both her experience and that of other people. However, she felt that if information *"didn't quite add up",* she would

look up the information. She did not take things at face value. She felt that some people working within the healthcare professions did not give accurate information about patients. She therefore, did not want to exact inaccurate information. This made her perhaps very critical and wary of her decisions. However, she said that she was indecisive and needed to see the full picture before going ahead and making a decision. I doubt very much that it was indecision here given her understandable reluctance not to make a decision before she got the full picture. This demonstrates the making of a good decision-maker, not an indecisive one. If she made the wrong decision, she would reflect on what she thought went wrong, review her thinking and consider what she could do better in future. She felt she was beginning to develop the thinking skills that enabled her to reflect on her decisions. She felt critical thinking skills were important to develop as a student radiographer and provided the following reason:

> *…everything is not always clear-cut as you anticipate it being. You have to think. If a patient is not ambulant you have to think, "how will I get those images?"*

Here she reasoned that one would sometimes encounter situations, which are not straightforward (clear cut), and one had to think deeper to bring about a clearer picture in relation to how to proceed. By referring to an ambulant patient above, she usefully exemplified her understanding by linking her explanation to an example from her clinical experience. She explained that critical thinking to her, in year one, meant *"looking at both sides of things."* She felt critical thinking could develop through clinical practice but appeared confused about how to apply critical thinking to undertaking an essay assignment, at the university.

In her second year of study, in response to the question, 'what do you understand critical thinking to mean?', her reply was the following:

> *I think critical thinking is taking a problem and breaking it down and finding the best way to solve whatever the problem is.*

She did not perceive a change in her understanding of the meaning of the critical thinking from her first year of study, yet the assertiveness with which she responded to the question told me her confidence had grown and she was sure of her response. She linked her understanding of what critical thinking meant to problem-solving. She stated, *"I am quite logical in how I approach a problem."* There was an inherent understanding underpinning her confident response; she appeared more comfortable speaking about critical thinking in her second rather than in her first year. Experience gained from writing university assignments helped develop her confidence, yet interestingly, she did not perceive her confidence to have grown from year one. Despite this her thought processes had begun to change. Experience gained from clinical placement helped solidify knowledge and understanding of performing routine

examinations, and she felt her thought process and actions, in these situations, become habitual. She felt new situations required more than just the routine application of thinking, where she had to think, "…*a bit more."* This could be perceived as having to think more deeply.

During the second interview, a critical thinking exercise was conducted involving a critical incident from Amelia's experience. The purpose of this exercise was to explore her ability to think critically and act accordingly. From the literature review, it is evident that critical thinking involves demonstration of higher order thinking skills and the disposition to use those skills, and these were the criteria that were explored during the exercise. The verbatim extracts from this exercise, conducted with Amelia, are presented below:

AR: So now we go onto the second part of the interview involving a real scenario from your experience. Can you think of and speak about a scenario where there were conflicting views?

> *Yes*

AR: Describe the scenario and how you managed the situation.

> *The scenario is a patient who needs a PA* (posteroanterior projection, see p. x) *chest X-ray and they* (the referring doctor) *wants the PA to measure the mediastinum. She* (the patient) *has already had an AP* (anteroposterior projection, see p. x) *which was done. The patient comes down and the patient is not well enough to stand for the PA chest, so the radiographers reluctantly do another AP film, but you are still not getting very good resolution in order to see the bases of the lungs and the heart.*

AR: What was your point of view in this scenario?

> *I looked at the clinical history which said that the doctor wanted a PA chest X-ray. The radiographers were the ones in charge and they decided that they will do an AP chest instead because the patient could not stand.*
> *So from their point of view, the patient could not stand so they decided to do another AP chest.*

AR: Describe how you felt about what happened.

> *I thought that it has given the patient an additional radiation dose which she did not need. She already had an AP chest a day ago. So, it seemed like a pointless thing to do from my perspective, as they will not have gained any additional information from doing the radiograph in the same way again.*
> *You know the doctor asked for a specific projection to look at a specific thing so doing what was done before was not going to give them that information. It was not going to help give them more information.*

AR: So in terms of evaluating this incident, are you able to make a judgment?

I suppose there were no pros only cons. The patient did not need the extra radiation dose and the image was not giving them (the radiographers) *any more information. So, if she* (the patient) *cannot stand you have to figure another way of doing it or not do it at all.*

AR: You have described your point of view and you gave a rationale for it, so tell me what happened thereafter.

They did the AP chest and still didn't get good resolution, so I turned around and said to them instead of standing her, can't we put the arm of chair down, swing her legs around and get her to lean against the bucky (See Glossary, p. xi) *so that you can get a PA chest. The detector is a digital detector which can be positioned just above her knees and she can just lean against it and we can get the PA chest that we needed.*

AR: What was your reason for suggesting that?

I don't know I just thought you still have the chair - it was about using my judgment, my powers of reason and I was having a look at what I can do and what I can't do, and the best possible solution within what I had within my control. And then we got the PA chest done and got good resolution where you could see the base of the lungs and heart shadow clearly.

AR: So are you able to make an appraisal of the whole event. What was learned in this event?

Even if you got the roadblocks or whatever where the patient cannot stand, there are ways you can get around it.

AR: Explain your reasoning process in reaching your conclusion.

I suppose I was thinking of a way to get the image that a doctor needed. I was looking at the whole situation rather than just the end result of it. I always think I have a more practical way of thinking compared to other people. Whereby you all want the result but not everyone looks at the whole situation in front of you. Some just look at the end result. For me, it's more systematic, more structured and I look at what I got at hand and that will give me the outcome I wanted.

I saw what the radiographers did and worked on that. I learned from that and thought well, "how can we get that PA chest." I looked at the chair and things that we had in the room. The arm of the chair comes down and if the patient was stable enough to swing round in the chair and face a different way, then we would be able to get the view of the chest that we needed.

AR: So you worked out that if you did this, this and this, then this will be the outcome?

Yes

AR: Why didn't you tell the radiographers this the first time when they were attempting to do the AP?

> *I'm just a student and did not feel I was senior enough to tell them about my point of view.*

AR: Okay, so what have you learned from this experience?

> *That you have to look at your surroundings, the situation first before forging ahead and doing the normal or routine thing. You treat every situation differently, and every patient and X-ray differently. Next time I will build on that experience and if I had a similar situation, I would try the other method. I would feel more confident to speak to radiographers about my point of view because I feel that I have that much more experience now than I did at that time, so I would speak to them and feel confident about it.*

AR: Are there any consequences of your action in relation to the incident?

> *The patient got more radiation but that was not through my action, that was through the radiographers' actions.*

AR: What might the implications for clinical practice be then?

> *We should be analysing the situation first before going ahead and doing what we think is the easiest way forward. Try a bit harder and sometimes what appears to be obvious is not helpful at all?*

AR: How would you describe the thinking that was used in this incident?

> *It was routine, habitual thinking which did not have a good outcome at first.*

AR: Did you feel that your critical thinking has developed from last year?

> *I suppose it has a grown a little as experiences like this have taught me not to be complacent and don't just go with what the radiographers would do, and not rely on what appears easier to do. You have to think a bit harder when the obvious does not work.*

The AP versus PA dilemma alluded to within this example relates to how a patient is positioned during a chest X-ray examination in order to get a good quality diagnostic image. AP refers to a radiographic position where the X-ray beam passed through a patient's body from the anterior (front) aspect to the posterior (back) aspect, hence AP means anteroposterior. The PA projection is the opposite where the X-ray beam passes through a patient's body from the posterior (back) aspect through to the anterior (front), hence PA means posteroanterior. The PA projection is best practice when imaging the chest as it yields the recommended diagnostic information to aid accurate diagnosis and minimises radiation dose to a patient's eyes, thyroid and gonads. Amelia demonstrated sound reasoning skills in relation to the position of the

patient regarding the requested information and makes a point about thinking beyond what was perceived to be the easiest option. Amelia demonstrated the application of skills of critical thinking in her quick and methodical decision-making process.

In this critical incident, Amelia was able to analyse and evaluate the situation considering the patient's individual circumstances and provide a clear and justifiable rationale for her point of view. The radiographer in the scenario chose to go ahead with another routine AP chest examination, due to the patient's condition, despite the doctor specifically requesting a PA chest examination. Due to Amelia's critical thought process, she was able to suggest an alternate radiographic imaging technique which enabled the patient to receive the requested examination. This examination yielded better outcomes for the patient as compared with repeating the radiographic technique that had already been undertaken. Her learning and development clearly demonstrated that critical thinking is thinking that goes beyond the surface of habitual thinking; it is a deep thought process, which, in this case occurred in-action and on-action.

Working with different radiographers at placement influenced her learning and understanding in a mainly positive way. However, at certain times she disagreed with radiographers' decisions, but felt intimidated by their seniority as she stated above. This represented a challenge she faced in her learning. Nonetheless, she demonstrated aloud her critical thought process thus confirming her critical thinking ability in the above-written scenario. In addition, she demonstrated her willingness to engage in and persist at a complex task, the avoidance of acting impulsively, and, being open-minded. These, according to Halpern (1989) and Facione (1990) are dispositions of a critical thinker.

In Amelia's third year of study, when asked about her understanding of critical thinking, she stated the following:

> *I honestly, don't get what critical thinking means...I think it is a deeper form of thinking, but I am not sure.*

Here despite stating that she did not 'get' what critical thinking meant, she was able to relate her understating to a 'deeper form of thinking.' When explored further she explained that she saw it in terms of being asked to *"...critically discuss and critically analyse…"* at Level six (See SEEC Descriptors in APPENDIX 2). The most significant influential factor in the development of her understanding was seen to be clinical placement. Below is what she stated:

> *It was a placement that helped a lot because you do a lot of decision making and the decision making is quite rapid due to patient safety issues* (because of the need to minimise ionising radiation doses to patients)*. In the first year you*

> *cannot just jump in and make decisions because you are just starting and don't have enough knowledge. Now I feel more comfortable making decisions.*

She felt she had more knowledge than in her previous year and has had the opportunity of making decisions at placement. The decisions must have had a positive outcome as that appeared to have boosted her confidence. She developed greater knowledge and understanding of diagnostic radiography by the third year of study and felt comfortable making decisions. This is a crucial step in the development towards autonomous practice.

When asked for her definition of critical thinking, Amelia offered the following definition:

> *Detailed, in-depth thinking, a different level of generally thinking. You have thought and then you have critical thinking. It is generally thinking but on a deeper level.*

Despite initially stating that she still did not understand the meaning of critical thinking, she was able to capitalise on her experience of learning to provide her definition of critical thinking, clearly making the distinction between critical and non-critical thinking. Throughout Amelia's three-year study she continued to consider herself as indecisive and lacking in confidence, yet underlying her perception of herself, was a deeper level of understanding about the meaning of critical thinking as seen through her responses to interview questions and prompts. Her understanding of a 'deeper level of thinking' indicates metacognition.

5.5.3. Case study conclusion

In this longitudinal story, Amelia's developing understanding of the meaning of critical thinking was presented. In addition, through her articulate responses during the critical thinking exercise, Amelia demonstrated the application of her critical thinking skills in action. Despite coming into university as a mature student unused to higher education study, Amelia demonstrated that her development of critical thinking skills, and her understanding of the meaning of critical thinking, grew from a nascent understanding and novice ability in year one to a more pronounced, deep understanding and level of proficiency in year three.

5.6. Chapter summary

This chapter has addressed key findings in relation to my second research question: "how do radiography students and tutors perceive critical thinking skills to develop through the radiography programme?"

The findings from the first phase interviews indicate only the sketchy beginnings of an embryonic critical thinking development. During the second phase interviews, clinical

placement learning played a profound role in the development of students' thinking and reasoning abilities. Understanding the consequences of decisions on patient outcomes sealed their commitment to ethical patient care ensuring they took the right actions. Students were able to relate their developing critical thought process to actual clinical scenarios from their experience and speak aloud their decision-making process. During the third phase interviews, students acknowledged the role of feedback in the development of their critical thinking. Students performed more complex procedures at clinical placement compared with year two, and this was instrumental in helping consolidate their learning enabling the transition to the autonomous practitioner. There were no new themes emerging from the third year interviews revealing that the themes had consolidated. The third year interviews therefore acted to validate the findings in relation to participants' perceptions of how critical thinking develops on the radiography programme.

The tutors' interviews revealed that students are exposed to low-level critical thinking tasks at Level four, with the expected increased demonstration of critical thinking in assignments at Levels five and six. Tutors encouraged students to question information at university and poor practice at clinical placement, recognising questioning as a key method of developing critical thinking skills. However, they acknowledged that critical thinking is a difficult skill to teach and develop. The tutors agree with the students in that teaching activities at university did not draw explicit links with critical thinking skills development. From the responses, it is evident that although students and tutors felt certain teaching and learning activities helped, more opportunity and practice is needed to develop critical thinking skills. The fact that students and tutors are saying the same thing, i.e. that critical thinking is implicit rather than explicit means that tutors are providing respondent validity, thus affirming this as a significant finding. Students do not know how critical thinking skills develop at Level four, but insightfully state that knowledge and understanding of radiography were required to aid its development.

Regarding the challenges in developing critical thinking skills, several areas emerged from both students and tutors which have pedagogical implications for the radiography programme. Although the education, training, and scope of practice of diagnostic imaging have changed, we are faced with the dilemma of a theoretical evolution versus a vocational evolution. In students' experience, the traditional practice of some radiographers affected their ability to apply critical thinking skills in clinical placement.

The single case-study presented demonstrated a student's typical growth in her understanding of the meaning of critical thinking, and in her development of the skills of critical thinking, as she progressed through her course from year one to year three. Her progression in relation to

understanding critical thinking was not clear-cut, in her eyes, indicating that the development of understanding the meaning of critical thinking, and its component skills, is a complex process. Her development was influenced by her learning from university and clinical placement.

Having summarised the findings in relation to participants' perceptions of how critical thinking developed through the programme of study, the discussion of the findings is presented in Chapter Six.

Chapter Six

Discussion of findings

6.1 Introduction

In this chapter, the two main themes of the study in relation to the meaning and development of critical thinking are theoretically analysed and discussed. The themes correlated with the meanings expressed by seminal authors within the literature review chapter. A definition of critical thinking applicable to diagnostic radiography education and training is proposed. In addition, a model for the development of critical thinking in diagnostic radiography is presented.

6.2. The meaning of critical thinking

In this section, the findings in relation to my first research question: What is radiography students' and tutors' respective understandings of the meaning of the term 'critical thinking? are discussed.

The findings indicated that the participants attributed the meaning of critical thinking to logical thinking. Critical thinking as logical thinking, explains Kuhn (1988), involves using reason to consider the available information in order to determine the outcome, i.e. to consider the information and available evidence from the premise through to their logical conclusion. This is summed up by Anastasiadou and Dimitriadou (2011) as involving the ability to analyse information, evaluate reasons and compare evidence, and drew parallels with my participants' responses. Additionally, there is an element of technical rationality that Schön (1991) speaks of which provides logical assurance to thinkers enabling them to make sense of the information. The participants indicated that they followed a process of deliberation before deciding what to accept as believable, which can be likened to McPeck's (1981) reflective scepticism. Judge et al. (2009) posit that just because something is in print does not mean that it is true; one needs to question the reliability of sources of information as identified by the student participants. According to Paul (1990), this represents a trait of critical thinking. Critical thinkers are known to recognise the importance of selecting information from reliable sources; they give less consideration to sources that they think offer a biased view. In being logical in their thinking, students must be able to make the distinction between those facts that are relevant to an issue and those which may not (Paul, 1990). This is borne out in terms of views

expressed by the participants, who realised the importance of choosing more than one source of information in order to appraise and evaluate information for university assignments. In addition, Kuhn (1988) stated that a major contribution to the development of scientific thinking skills is the reasoning required in the differentiation between theory applicable to the situation at hand and the evidence. She clarified that awareness of their differentiation contributes to the deliberation of the relationship between them. This is where evaluation of the situation in light of the evidence, is crucial in one's ability to logically develop an argument, either for or against the issue at hand. According to Biggs (2003), this constitutes a deep learning approach that uses higher cognitive engagement, i.e. thinking that goes below the surface data or facts, as identified by my student and tutor participants.

In analysing information, the participants made assumptions about the relevance and accuracy of information and how well the reasons support the action or belief. Kovic (2016: 24) states that critical thinking is better understood as a critique rather than criticism. Being understood in this sense implies that critical thinking is a 'thorough and justifiable assessment and not merely an expression of disagreement.' This is particularly important, states Paul (1990), due to the human tendency to sometimes ignore, distort or dismiss information unfairly. It is relevant to radiography practice where students' reasoning process must ensure that the benefit of treatment outweighs the risks of radiation involved and must always be at the heart of all considerations (Durand, 1999). However, Halpern (1989) explained that nobody can become better at thinking just by reading. One must develop the attitude of a critical thinker. She reminds us that "many errors occur not because people can't think critically, but because they don't" (Halpern, 1989: 29). This attitude requires thinkers to be motivated, willing to make a conscious effort to work in a planned way, in gathering information, checking for accuracy and being able to persist when the solution is not straightforward. These make up some of the necessary dispositions of a critical thinker (Halpern, 1989). Paul (1990) agreed by asserting that the big difference between good and poor thinkers is their attitude. One of the biggest challenges in developing a critical thinking attitude is that people do not realise when they are thinking or acting impulsively (Halpern, 1989). Some people who choose not to think, as recounted by the participants, appear to be defeated at the start; they may be faced with a seemingly difficult problem and decide not to think about it. Others will start a task but will stop short of completing it. "Good thinking is hard work that requires diligent persistence" (Halpern, 1989: 30), hence the participants' belief that students find it "*hard"* to think. If students do not think, there are ramifications regarding their ability to pass university assignments and work proficiently in clinical placement. This is an important stance to maintain, especially when dealing with diagnostic imaging examinations that involve ethical dilemmas where there are many patient care factors to consider. Their thinking abilities will also call into question their

fitness to practice as a student radiographer (HCPC, 2016). Student radiographers, therefore, need to be able to articulate clearly their descriptions of thinking in a way that demonstrates their understanding by using examples or ways of explaining their understanding, i.e. they must demonstrate how information makes sense to them. Merely stating that it does, does not qualify or justify it. The student and tutor participants identified positively with this expectation.

The findings also indicated a significant link between critical thinking and decision-making. There is agreement from Halpern (1997) and Ennis (1987) that decision-making, which is considered a higher form of thinking, is based on aspects of thinking such as analysis, evaluation and inductive and deductive reasoning. Decision-making has applications in justifying statements, reasoning from premises, analysing arguments, thinking creatively and making decisions (Ennis, 1987; Halpern, 1997). In addition, Jeong (2015) mentions a positive correlation between critical thinking dispositions and decision-making and problem-solving abilities. The process of critical thinking has sometimes therefore been used synonymously with decision-making (Jeong, 2015). Furthermore, many definitions of critical thinking involve making a judgment of how to use information radiographers are given in their decision-making process. Simpson and Courtney (2002), for example, claim that decision-making needs to utilise critical thinking as an important step in the thinking process in order to "reframe a problem or situation" (Simpson & Courtney, 2002: 94). Facione and Facione (1993, in Simpson & Courtney, 2002: 94) also describe critical thinking as a "cognitive engine that drives decision making." Analysis and evaluation are cognitive skills of critical thinking which form an important part of the decision-making process (Halpern, 1989). This cannot be done by rote learning (Halpern, 1989). The process of decision-making requires critical thinking skills. Both of these skills, therefore, should not be used interchangeably due to the former being dependent upon the latter (Halpern, 1989).

In addition, Bailin et al. (1999) affirmed that critical thinking is 'good thinking' where the quality of thinking and not the product of thinking is important in separating critical from uncritical thinking (see Section 4.4. for more detail in this regard). This is important to radiography students when considering options available in the clinical environment and being able to ensure that a patient's individual care needs are being met. The application of the decision-making process is therefore integral to clinical radiographic practice. With respect to the decision-making process, the student participants likened the outcome of their thinking to a goal which in this case is the decision. Support for their comments can be found in the work of Halpern (1989) who clarified that a goal in thinking can include, a decision among a set of likely solutions, finding a solution to a problem where there appears to be none, putting information together, appraising the credibility of evidence or information sources or

considering causes of events, especially when things go wrong resulting in a poor outcome for the patient.

Exploring alternatives is crucial to the reasoning process and is a lateral thinking strategy or thought process as considered by Brookfield (2002). Alternatives are usually options to habitual behaviors and fixed belief systems (Brookfield, 2002), which in the case of diagnostic radiography would be prescribed imaging protocols. Critical thinking must always be thinking about something (McPeck, 1981), where the 'something' is the purpose of the thinking process (Halpern, 1989). The process uses the higher order thinking skills as well as subject-specific knowledge and experience, i.e. knowledge of diagnostic radiography practice. Cognitive knowledge and experiential knowledge, therefore, contribute to a decision-making process; this is the thought process that is equivalent to critical thinking. According to Papell and Skolnik (1992), the constructivist view lies within the phenomenological framework where one's interpretation of society influences one's behavior and /or actions. As such, Schön's (1991) reflection-in-action is founded in the constructivist perspective of reality, which lies within the profession-specific discipline of the practitioner. When applied to radiography practice, students make decisions based on their interpretations of their social reality, the radiology department and the patients in it. Using reasoning skills and choosing alternatives are required, for example, when interpreting and accurately reporting on a radiographic image. On radiographic images, a number of aspects of image production and patient anatomy can present with shadows that can mimic pathology (Dictionary.com, 2018e), for example, magnification of the heart can occur on a chest X-ray image if a patient is positioned incorrectly. Student radiographers, therefore, must be able to reason through multiple options and alternatives, during their decision-making process, rather than leaping to the first plausible option.

Participants in my study described their understanding of differences between critical thinking and uncritical thinking. The latter, in their opinion, took the form of habitual thinking, where thinking is based on past practices and no new information is taken into account, as used in routine situations. However, it can also take the form of 'brainstorming' whereby a person says whatever comes to mind at that time without evaluation of information. Brainstorming, though, from a basis of expertise and advanced levels of knowledge argues Paul (1990), can be illuminating and a high order level of thinking. In comparison, the definition of lower order thinking is learning through rote, association or memorisation of the subject matter (Newman, 1990), and is mainly associated with school learning (Paul, 1990). This is the kind of thinking that is used in "*clear cut*" explanations as stated by participants, where there is a relative lack of logic informing their learning (Paul, 1990). Hence thinking can be critical or uncritical. An

uncritical thinker is one who is "unclear, imprecise, vague, illogical, unreflective, superficial, inconsistent, inaccurate, or trivial" (Paul, 1990: 53).

Tutor participants identified the expectations for critical thinking development from lower order critical thinking at Level four to higher-order critical thinking at Level six, where their ability to critically analyse and interpret information are assessed. They also recognised the need for learning and teaching exercises to develop students' critical thinking abilities and felt that those activities should be offered from Level four. Didactic teaching with extensive coverage of subject content without interaction and opportunity for questions breeds passivity in students and perpetuates lower order thinking traits in students. See Chapter Two, pp. 40-41. for more discussion on higher and lower order thinking.

Participants recognised that no critical thinking in radiography is entirely cognitive. Social, affective, emotional and moral considerations as far as patients are concerned need to be made (Ennis 1989; Facione, 1990; Jasper, 2003). For example, if a patient is to undergo an MRI scan, then a student radiographer or radiographer would explain the nature of the examination including details about the scanner having a narrow tunnel, and that some patients feel claustrophobic during the examination. The explanation to the patient would include the facts about the examination as well as an explanation of what the patient is likely to experience before, during and after the scan. The aim of the explanation will be to inform them about the scan as well as adequately prepare them in order to alleviate their anxiety. Understanding the need to alleviate a patient's anxiety is a demonstration of empathy (Simpson & Courtney, 2002). Thus, radiographers in their explanation to patients use both the cognitive and affective skills taking into account the examination and a patient's concerns.

In addition, Jang (2013, in Jeong, 2015: 45) posits that empathy critically affects a person's "internal responses and decision making" which can result in either negative or positive outcomes for the patient. With respect to the potential for negative levels of stress in radiographers, this may, impact negatively on their critical thinking ability. On a similar note, Brookfield (2002) mentioned that a person's emotions may affect the way in which they analyse information, make decisions and take action within the critical thinking process. The participants justifiably spoke about the ability to make rational decisions while acknowledging that if they used emotion it could affect their decision. The ability to care about your role as a student radiographer means that you have the disposition towards gaining a fully informed understanding of your patient's needs and using that information in your decision-making process. This appears congruent with the findings of the study conducted by Pai et al. (2013) where they report that nursing students who evidenced greater caring behaviors demonstrated

more positive critical thinking abilities. As seen thus far from both the literature and findings, critical thinking has been described as logical thinking. As radiographers, we must remember that logical thinking exists alongside empathy and concern for the emotional well-being of others. The fact that students were able to recognise this demonstrates their developing understanding of not just the cognitive skills, but also the affective dispositions of critical thinking in relation to patient care in diagnostic radiography.

From the findings, participants indicated a link between critical thinking, reflection, and metacognition (See Section 4.4, p. 100). Through their articulations, participants indicated that they continually questioned their own thoughts and assumptions; this was an indication of thinking or reflection on thinking. Brookfield (2002) says that this is true of critical thinkers; critical thinking is not static. Critical thinkers tend to view their thinking as a process rather than an outcome (Simpson & Courtney, 2002), as evidenced in my findings. It is likely therefore that practitioners continue to revisit their thought processes long after a decision has been made as stated by participants. In reflecting on one's actions or decisions, one is appraising one's behavior and this task involves the processing of cognitive and affective skills (Gloudemans, 2013). This is where reflection on one's decisions, or actions, come into the critical thinking process; reflection on one's thinking is an important factor in self-correcting behaviors (Lipman, 1991). The reflective thought process also involves thinking explicitly about the nature of the 'something', the evidence surrounding it and how these shapes one's beliefs about it (Kuhn, 1984). These cognitive processes require varying levels of cognitive engagement. In particular the 'why', and 'what if' of the 'something' requires deeper cognitive processing which is higher-order thinking (Anderson & Krathwohl, 2001). This compared with the 'what' and 'how' of the 'something', that takes place at the beginning of the reflective process, requires a description of the event, which is not necessarily negative, but rather an important part of the process in moving from description to analysis. As stated by participants, the process of reflection involves the process of analysis and evaluation which are skills of critical thinking. Thus, it can be summed up that reflective thinking uses the skills of critical thinking. Critical thinking skills and reflective thinking skills are therefore inextricably linked. This is well described by Charlie (IV3) and Jacob (IV3), see Section 4.4, p. 100.

Self-knowledge is an important component of metacognition and includes knowledge of one's strengths and weaknesses and one's limitations (Pintrich, 2002). Self-awareness of a student radiographer's breadth and depth of knowledge, and scope of practice, is of paramount importance to personal practice as a healthcare practitioner, as identified by my participants, see Section 4.4, p. 100. Self- awareness will help students self-regulate their practice as a result of self-reflection and be aware of their limitations in relation to their scope of practice

(Edwards, 2006). Edwards warns however that self-regulation, being an intellectual skill, does not come naturally for students, implying a need for this skill to be cultivated through learning. Being aware of one's thought alludes to conscious thinking, which is supported by the work of Jasper (2003) who asserted that the fundamental aspect of reflective thinking is consciously thinking and knowingly considering our experiences to draw out our learning, as identified in my students' responses. In short, she believed that "learning is a deliberate act" (Jasper, 2003: 9). Awareness of self-knowledge helps students take stock of their strengths and limitations.

However, knowing-in-action, according to Wieringa (2011), happens by routine everyday actions, similar to participants' responses. He elaborates that practitioners must think about what they are doing while they are doing it. An example of one such reflection-in-action can be found in Amelia's case study, see Section 5.5, p. 134. When intuitive or spontaneous performance brings nothing new to the learning experience then, as practitioners, we tend not to think about it. If there is something new or unexpected we then respond by reflecting-in-action or thinking whilst we are doing. This entire process of reflection-in-action is the key to a practitioner's ability to deal well with situations of conflict, uncertainty, and instability (Wieringa, 2011). Schön (1991: 61) posited that when practitioners are actually reflecting on their "knowing-in-practice" their performance can result in a change in the course of action or strategy that is required at the time. Practitioners also reflect-on-action which takes place after the issue or situation had been dealt with, and while gaining new insights from this reflective process is a useful exercise, it can no longer have any influence on the event in the past (Schön,1991), as identified by the participants. Kuhn (1999: 23) stated that the "development of metacognitive understanding is essential to critical thinking because critical thinking by nature of its definition involves reflection on what is known and how that knowledge is justified." Kuhn, in relation to this comment, considered critical thinking as a form of metacognition, which concurs with Schön's (1991) notion of how professionals think-in-action.

6.2.1. Definition of critical thinking applicable to diagnostic radiography practice

Following analysis of findings and exploration of participant views on a definition of critical thinking, a definition framework of critical thinking applicable to diagnostic radiography practice was devised. The framework and proposed definition encapsulate the views of participants, my conceptual framework and my reflexive understanding of the nature of critical thinking in diagnostic radiography practice.

In defining critical thinking, Paul (1992) believed that having a single definition of critical thinking is limiting as it will not adequately consider the breadth and scope of the meaning of

critical thinking. He suggested the consideration of a range of perspectives. However, is this not what we currently have in the published domain, a myriad of plausible definitions but no best fit for diagnostic radiography? A discipline-specific definition is therefore needed. Furthermore, in defining critical thinking most authors attributed meaning to a different aspect of its operational nature and always defined it as something that happens in the past (Anastasiadou & Dimitriadou, 2011). Definitions from Ennis (1989), Halpern (1989), and other authors, have been considered in the literature review chapter; the meaning attributed to critical thinking largely consisted of various descriptions of using cognitive skills and having the attitude and disposition to use the skill. Due to critical thinking being comprised of skills and dispositions, it is very difficult to conceptualise its meaning as being separate from its operational nature. Dwyer et al. (2014: 47) sum up the skills of analysis, evaluation, inference and reflective judgment as the "cognitive backbone of critical thinking." Like Dwyer et al., Geng (2014) explored the meaning of critical thinking with sixty-four participants. His study revealed that judgment, argument, questioning, information processing, problem-solving, metacognition, skills, and dispositions, form the meaning of critical thinking. These concepts broadly match the participant responses. Furthermore, Kuhn (1999) advised that it is crucial to define critical thinking in a way that there is general applicability across a range of content, and that the definition must sit within a developmental framework of where the cognitive skills come from and where they are going. An advantage in defining critical thinking from the study is that the definition was explored in a context-specific way as the participants are involved in the practice of diagnostic radiography. So, the exploration was a useful indicator of participants' opinions following their experience. Unlike Halpern (1989), whose definition contains only skills, and Ennis's (1996), whose does not, the definition I propose is based on the participants' views, my views shaped by my reflexive position, and my conceptual framework.

As a radiographer, the way we approach critical thinking in the clinical department is twofold: one aspect considers the need to produce a diagnostic image keeping the radiation dose as low as reasonably achievable; the other lies in managing the psycho-social aspects of patient care. Our role involves a balance with due regard to both these considerations. The definition, therefore, has to include these differing and complex dimensions, hence the framework I propose in Figure 6.
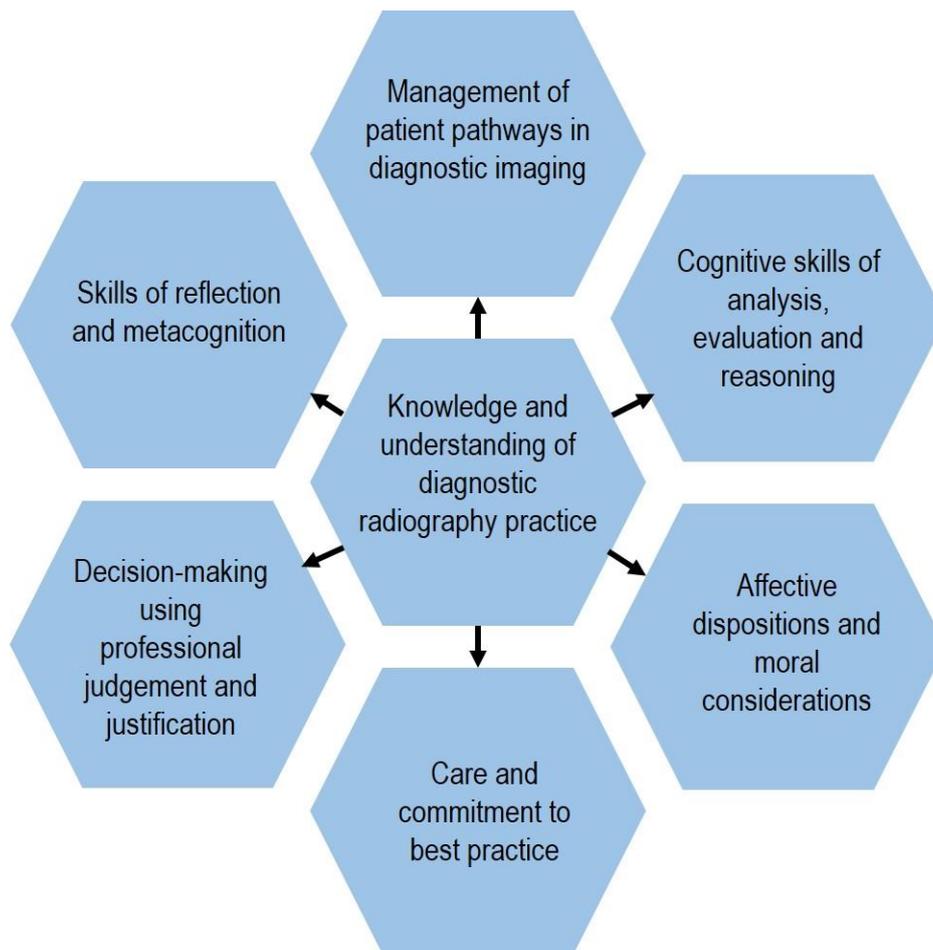
Figure 6. A definition framework of critical thinking in diagnostic radiography practice.

The various related components within this framework draw together the multiple dimensions of this complex construct from a diagnostic radiography perspective. Knowledge and understanding of diagnostic radiography practice are pivotal to all aspects of critical thinking in autonomous practice and is therefore crucially positioned in the middle of the figure. The individually illustrated hexagonal components fit together like a honeycomb illustrating the building blocks of the specific understanding of critical thinking as applied to diagnostic radiography, as demonstrated by the findings. This framework draws together the multiple facets of critical thinking considering the role and expectations of the radiographer and makes a unique and novel contribution to education and training. From this framework I propose a working definition of critical thinking in diagnostic radiography as follows:

The critical thinking required of a diagnostic radiographer is to use ethically sound professional reasoning in making justifiable decisions in relation to examinations, diagnosis, and management of the patient within the field of medical imaging.

This definition positions 'critical thinking' within the diagnostic radiography discipline and is contextualised in its application within practice. The immediacy of the decision is in relation to the patient at the time of examination, however, inherent within the justification is a thorough background knowledge based on their skills of appraisal in choosing what they believe will work and be of benefit to the patient. In order to justify their decision students and radiographers need to have critical awareness of the underpinning knowledge and debate in relation to what is right in the given situation. This discipline-specific definition is a new addition to the existing body of critical thinking knowledge within the profession and practice of diagnostic radiography.

6.2.2. Summary

In this section, the theoretical discussion is presented in relation to my first research question: "What is radiography students' and tutors' understanding of the term critical thinking?" A definition framework and a working definition of critical thinking from the concise integration of findings from participant responses, the literature, and my conceptual framework, are also presented. The multi-faceted definition framework takes into account key considerations, skills and dispositions for critical thinking in diagnostic radiography, and in so doing draws together the purpose of critical thinking in diagnostic radiography practice and makes an original contribution to education and training.

6.3. Perceptions of how critical thinking develops

In this section the findings are theoretically discussed in relation to my second research question, "How do radiography students and tutors perceive the development of critical thinking through the programme?" The findings in relation to the challenges of developing critical thinking, however, are discussed in Chapter Seven.

In contrast to the vast amount of literature on the meaning of critical thinking, the development of critical thinking has received relatively little attention and focus from educational philosophers and psychologists. From the findings, student participants expressed the value of feedback in developing critical thinking abilities. When they discussed their feedback with tutors, they learned about academic writing conventions and having discussions on aspects of their writing helped to develop their personal learning experiences and higher order thinking skills. Their analytical and evaluative skills had, therefore, strengthened leading to better feedback and a better grade on their next assessment submission. This development in their

thinking abilities, following feedback, has been reported by participants as a positive outcome of university learning. In addition, the grading criteria based on Blooms' taxonomy (1956) places a strong emphasis on the achievement of critical thought in year two with greater emphasis in year three. Marzano and Kendall (2007) postulate that the ability to apply the higher order skills of thinking is available to students at any time; they can, therefore, attain new knowledge without following the hierarchy of knowledge development as presented in Bloom's taxonomy. In relation to the expectation of critical analysis in assessment and feedback, students have stated that tutors did teach critically, but did not link learning and teaching activities to critical thinking. Despite this most students demonstrated that they were achieving the skills to pass each year. It must be acknowledged, however, that the skills were being achieved at a lower level than what would be considered as a good grade, i.e. below a 60% grade. In higher education, a grade above 60%, i.e. 2:1 or a 1st, is considered as a good grade.

The findings revealed that the greatest growth in students' learning and development took place between the second and third phase student interviews. Students were often tasked with activities at clinical placement that required knowledge and skills which they have not yet learned. They could not, therefore, as Pintrich (2002) argued, rely on prior knowledge or skills as they are faced with essentially new situations. As students developed, they accumulated knowledge about a variety of tasks, for example, writing essays, performing routine radiographic examinations and so on. They also had awareness that the various tasks required different levels of cognitive engagement and may, therefore, use different cognitive strategies. Two popular strategies for learning that may help in such situations, according to Pintrich (2002), is a recall task and a recognition task. In a recall task, students need to actively search through memory in an effort to retrieve the stored information during examination settings; in the recognition task they need to discriminate among alternatives in order to select the appropriate response (Pintrich, 2002). In comparison to university examinations, clinical placement learning is hands-on: the learning is through recognition and observation rather than through recall. This could be the reason why students struggle with academic writing and assessment as compared with relatively better performance in clinical practice related tasks and assessment. As the students demonstrated better performance in clinical related tasks and assessment, it can be inferred that they were better at learning through recognition, observation and scaffolded support from experienced radiographers rather than through recall alone.

Students in my study spoke about their deliberation over decisions taken as a result of evaluating their thought process. This is linked to metacognition which has been described as

"thinking about thinking" (Halpern, 1989; Paul, 1993; Kuhn, 1999). "Metacognitive knowledge involves knowledge and cognition in general, as well as awareness of and knowledge about one's own cognition" (Pintrich, 2002: 219). Self-questioning, therefore, requires metacognitive skills and contributes to their intellectual maturity (Desautel, 2009), as indicated by the students. Metacognition has been included in Bloom's revised taxonomy of the cognitive domain. Pintrich (2002), however, clarifies that the aim is not for tutors to formalise assessment of students' cognition in this regard. Instead, it is to draw attention to the fact that metacognitive knowledge is important to how students facilitate their own learning. He suggests that tutors raise awareness of metacognitive knowledge in the class and listen to students talk about their learning and cognition. However, in the clinical setting, there may be limited time for this activity as espoused by Schön (1991) who cautions practitioners about reflection-in-action saying that while it is feasible, there may be little time to stop and think. Schön explains that during activity when we think about what we are doing, the complexity of the situation can actually hinder the fluidity of action. This gets better with practice though as seen in the Dreyfus model (1996) of the novice to expert development. Nonetheless, as practitioners, we must be mindful of Schön's (1991) advice. Metacognition can develop by offering learners a curriculum that offers constructive discussion and questioning, where criticism is a frequently used method of inquiry rather than the exception. If students are exposed to this kind of learning, over time the "reflective activities become internalised as self-reflective practices" (Brown, 1997, in Kuhn, 2000: 181). This is a pedagogical consideration and is discussed in the next chapter.

In my findings, student participants spoke about their experience of theory to practice learning, the need for decision-making and using good judgment. They also spoke about the difficulties faced in their learning. The purpose of students attending clinical placement is to develop the practical skills and attributes of their profession. A clinical placement environment also enables learning through the application of skills which are the skills of radiographic practice, involving technical skills, as well as the cognitive skills of critical thinking. Although it is relatively simple to teach student radiographers the techniques required to master the clinical radiographic practice skills, it is much more difficult to teach them how to learn to use their thinking abilities to the extent required in graduate autonomous practice. We cannot teach students how to think; we can, however, teach them to learn in order that they think well (Dewey, 1933). During the second interview phase, all student participants related their understanding of their critical thinking development to a critical incident from practice. A critical incident is an event that "stands out in your mind and contributes directly to your development as a practitioner" (Jasper, 2003: 13). In so doing, they linked theory with activities in a clinical setting, which required analysis of the individual components of information, then evaluation and synthesis

when they all came together in the learning process (Edwards, 2003). Developing critical thinking abilities will therefore deepen their ability to reflect and link theory with practice, as also seen in Amelia's case study (see Section 5.5, p. 134). By the end of the third year of study, student responses demonstrated that their knowledge and understanding, gained over time, helped to shape their thinking process.

In student feedback from clinical placement, students reported that they usually felt drawn towards radiographers who were experienced in their roles and were confident in their practice. However, the hierarchical structure of radiology department services sometimes made it difficult for students to question the decisions made by supervising radiographers hence was perceived to have negatively impacted on their development in certain cases. Radiographers have long worked in this traditional hierarchy with strong medical dominance from radiologists, and over the years became compliant in an effort to be included as part of the radiology team (Edwards, 2006). Working in this traditional setting runs counter to the innovation and the creation of improvement: it breeds a culture of conformance (Edwards, 2006). Sim and Radloff (2009: 3-4) state that workplaces, which do not support critical thinking, stifle inquiry and "inhibits the development of new and better practices." This type of culture does not enable the development of critically reflective practitioners. Sim and Radloff (2009: 3) further posit that radiographers have focused on clinical competence, strict adherence to protocols and a lack of functional autonomy in the workplace. This adversely impacted upon student radiographers' motivation, willingness and ability to learn (Sim & Radloff, 2009). They go on to state that this is not just an issue with workplace culture, but rather one that needs to be resolved through the educational process by creating a culture of critical reflection from the beginning of the educational process. Furthermore, Ludin (2017) found in a study involving critical care nurses that the age and working experience of nurses significantly impacted on their clinical decision-making abilities. The findings promoted the recommendation that critical care nurses should improve their decision-making in clinical practice by developing higher order thinking abilities, for autonomous practice. Radiography students have been traditionally socialised to value obedience, respect authority and show loyalty to the team (Yielder & Davis, 2009). Indeed, Edwards (2006) explains that clinical tutors must be sufficiently approachable enough so that students can develop trust and confidence in them and feel comfortable in approaching them. She further asserts that if students feel ridicule or humiliation at clinical placement that does not make a good learning environment for the development of independent thinking. "A complacent, dogmatic, authoritarian, with twenty-five years' experience, will undoubtedly fail to develop critical thinking in their pupils" (Edwards, 2006: 211). As a tutor, I can support this based on my experience of receiving student feedback where they felt ridiculed and intimidated in the placement learning environment. The need and

importance of role models, to bring about transformational learning experiences for students in clinical placement, has been well demonstrated in my findings, through both student and tutor responses.

Participant responses in my study confirmed that a clinical placement environment plays a pivotal role in student learning and provides the canvas for students to develop and apply their skills of critical thinking. It provides opportunities for transformative learning or deep approach to learning that goes beyond "knowledge or memorising information" (Hendry, 2013: 255). Hendry (2013) goes onto say that this involves being critically reflective where you are thinking for yourself and transforming through your learning experiences. Radiographers could act as "transformational leaders" in clinical practice and educate students in the clinical environment by "transformative teaching", as previously discussed (Hendry, 2013: 255). This is not an unrealistic expectation as the National Health Service (NHS) expects its healthcare professionals to model their values and behaviours (NHS, 2015). Hendry (2013) concludes that transformational leadership could enhance students' experience and knowledge, which in turn can cause them to aspire to aim higher in their own radiography careers in the future. The NHS continues to be dynamic in its response to change. Reports following investigations, for example, the Francis report, following the Mid Staffordshire NHS Foundation Trust public inquiry, feature the words 'accountability' (Francis, 2013). Radiographer training and development, therefore, needs to consider the seriousness of accountability and leadership, and thus deal with the apathy in the profession (Yielder & Davis, 2009).

In a study, conducted on healthcare students by Mawn et al. (2011, in Hendry, 2013), there was a positive correlation between transformational leadership behaviours and student motivation, satisfaction scores, and outcomes. This could, therefore, impact positively on the notion of role modeling behaviours for positive student learning experiences. From the students' responses in my study it was clear that some radiographers challenged them beyond their scope of learning to a higher level of learning. The radiographers' actions, therefore, have clear parallels with scaffolding in learning (Woods et al., 1976). This involves the helpful interaction of a radiographer in enabling a student radiographer to achieve a goal; managing a challenging situation, for example. Bruner describes scaffolding as "the steps taken to reduce the degrees of freedom in carrying out a task so that the child (in this case, the student radiographer) can focus on the difficult skill they are in the process of acquiring" (Bruner,1978:19). The radiographers' actions helped co-construct learning by taking students a step higher in their learning, than the one they had already mastered. Vygotsky (1978) calls this extension of student learning, the 'zone of proximal development.' See Chapter Three,

pp. 54-55. Nonetheless, as also mentioned by tutor participants, the students had experience of both sides of practice.

The participants in my study also described the importance of moral considerations in their decision-making process. Critical thinking "must always inform the moral compass" (Natale et al., 2016: 45) where there is a requirement to understand the moral complexities of a situation and to move your behavior in order to affect the right position, like a compass. This approach warrants a careful analysis of the problem at hand as well as its implications, as identified by the participants. Both Ennis (1985), and Dewey (1991) discuss the position of morality within their definitions of critical thinking (See Section 2.4, p. 22). Dewey professed that one should withhold judgment and invite healthy scepticism; Ennis asked that those making the decisions are reflexive in their consideration. By so doing the outcomes of the decisions bear an assurance that the best alternatives that meet the criteria for 'good and true' have been achieved (Natale et al., 2016). The importance of ethical considerations in decision-making appeared particularly poignant in the responses during the students' second and third year interviews.

The participants in my study acknowledged that different situations, namely in simple/routine versus complex situations, require different approaches to thinking and decision-making (Halpern, 1989). As the students progressed from years one to three, the examples they articulated became more complex; this was indicative of their learning. Routine thinking was linked with basic knowledge and understanding, which is the foundation of knowledge, and involved lower order thought processes (See Chapter Two, pp. 40-41). Much of a student radiographer's confidence, however, depends on the frequency of performance of similar radiographic examinations. This is where students gained experience from repeated exposure to the same examination and had the opportunity to reflect on their experience thereby gaining a deeper understanding of those imaging examinations resulting in confident practice in those examinations. Complex situations require the consideration of options when routine protocols and practices are no longer sufficient or appropriate. It was during these moments of deep thinking and deliberation of alternatives that their critical thinking skills began to develop. This has parallels with the proficient stage of skills development as stated by Dreyfus and Dreyfus (1996). The participant responses align with view of Andrews and Roberts (2003) who note the relationship between student and radiographer mentor changes over time; students require less supervision as they progress in their learning. More senior students, therefore, require less supervision and observation. They may require help when presented with a new area of learning or a new technique. Their learning, therefore, was dynamic and shifting in keeping with the situation or examination they encountered.

The participants acknowledged decision-making as an essential feature of diagnostic radiography practice, as reported in Section 6.2. The use of critical thinking, as a framework for decision-making, is central to the accountable delivery of care (Hoffman & Elwin, 2004). Decision-making in clinical practice has been well researched within the nursing profession (Ashley & Stamp, 2014), with several models published, most notably those of Benner (1984) and Tanner (2006). As a nurse becomes more proficient the process of decision-making becomes "easier, more manageable and increasingly delicate" (Banning, 2007: 188). According to Tanner's model, clinical judgment depends on noticing the key aspects of a situation or, in the case of radiography, an examination request; then by interpreting the information, followed by responding where appropriate actions are taken, resulting in reflecting on the process that was followed. In summary, Tanner (2006) posits a process of noticing, interpreting, responding and reflecting to be used in the process of arriving at a sound decision. Tanner additionally reported that nurses used a range of reasoning patterns, i.e. analytical, intuitive and narrative thought processes in their decision-making. Although radiography students' reasoning patterns were not explored within my study, they did refer to the use of analysis, intuition and 'think aloud' methods in their decision-making process. In the first year, students did not have the theoretical knowledge or clinical experience to reach what Ashley and Stamp (2014) call the 'the high level of cognitive maturity' that critical thinking requires. In my findings, students stated that through their experience of working with patients, they learned to work as student radiographers, and, as their technical skills developed so did their critical thinking skills.

In addition, Hedburg and Larson (2003) explored nurses' clinical decision-making strategies and found that nurses regularly corroborated with colleagues, especially those who were senior to them. This process was seen to validate the nurses' decision-making and act as a sounding board for decisions taken. Banning (2007) states that collegial verification is often linked to indecision and uncertainty. Similarly, the participants demonstrated that they were willing to think aloud their decision-making process so that they got audible confirmation of their thought process, which reduced the potential for errors in their decision-making process. This led to increased confidence in making independent decisions thereafter, especially in certain situations, such as in A & E settings which are often timelimited, often performed with insufficient information, and frequently tacit (Price, 2015). Although the think-aloud method of confirmation was perceived to have aided students' learning, Andrews and Roberts (2003), warn that using this technique, while engaged in clinical action, may prove difficult, arguing that when a practitioner stops to think, their actions cease and thinking 'about' rather than 'in' action follows, a position underpinned by Schön (1991).

Participants in my study, through their expressed responses, indicated a pattern of development that has similarities with the novice to the expert model of development postulated by Benner (1984), and Dreyfus and Dreyfus (1996). In their five-staged model, novices firstly begin by working through fixed instructions or rules. Being new to the university and practice setting, students tend to focus on using memory, gathering information and are dependent on others for instructions on what to do. Prior to students' attendance at their first clinical placement, they are prepared for their learning experience by undertaking a number of training sessions at university. Within those sessions, they are given the standard radiographic techniques for a range of appendicular and axial radiographic examinations. They attend their first placement block and work in accordance with these techniques, where they are not to deviate from this. Indeed, these are the rules that Benner speaks about within the novice performance. This rule-governed behaviour is limited and inflexible since novices have no experience of the situation they are faced with. This is because although they have knowledge of the theory from the classroom setting, they have little contextual knowledge of the judgment required in a real, clinical setting. They are therefore unable to use discretionary judgment due to their lack of experience.

In the second stage, an advanced beginner has a little more experience of being in a real situation and can demonstrate a "marginally acceptable performance" (Benner, 1984: 22). This process happens at the beginning of the student radiographers' second year of study. Here they are familiar with the routine radiographic projections learned in their first year of study and are able to make decisions within their limited scope of practice.

The third stage of the model is called the competent stage where the practitioner has had experience of working in a similar situation for about two to three years. The practitioner's practice is based on a plan that is established on conscious, abstract and analytic contemplation of the problem at hand.

The fourth stage is called the proficient stage. This involves a greater degree of perception from a practitioner where, as explained by Dreyfus and Dreyfus (1996), practitioners understand the situation as a whole and take into account the perceived outcomes of patients. A practitioner learns from experience what to expect in a given situation and how to modify plans in response to the situations. According to Dreyfus and Dreyfus (1996), there is a qualitative leap in the form of a transformation (Benner, 1982), where competent practitioners, and proficient practitioners, will handle the same situation in different ways. The latter use past

experiences to guide them; this improves their decision-making as postulated by Benner (1982; 1984).

The ultimate stage, the expert stage, is the stage of development that does not rely on analytic principles or rules in order to take appropriate action. Expert practice tends to be more constructivist and self-directed in nature, which Schön (1991: 50) called "intuitive or spontaneous." This operates from a deep understanding of the whole situation, where their performance becomes fluid, flexible and highly proficient. When in situations where there is a sufficient body of experience, decisions are made intuitively. However, when experts are faced with situations with no previous experience, they need to go back to the competent stage where they must analyse the information available and make a reasonable appraisal of the situation before deciding how to act. When alternative perspectives are not available, the only way out of a problem or a new situation, (Benner, 1982), is to recall the rules and scientific knowledge, and use analytic problem-solving. In certain situations, therefore, an expert regresses, indicating that the development of expert practice is a nonlinear, shifting process, as experienced by the students in their third year of study when faced with a higher level of complexity. It must be clarified nonetheless that students move from novice students to expert students during the course of their training. They will not have achieved expert levels of practice until a few years post-qualification, with continued professional development.

When students spoke about their mechanical way of doing a chest X-ray, for example, where they did not have 'think' about the examination, they were using their intuitive thought process which was informed by previous experience. Benner (1984) explains how an inexperienced or novice practitioner will use protocols and guidelines to help them get started in their learning; after a period of time, their decisions and actions become intuitive based on their past experience. According to Rew (2000: 95) intuition is the "sudden awareness of knowledge that is related to previous experience, which is perceived as a whole and difficult to articulate." There is a correlation between intuition and experience in working in practice: as experience increases the ease with which nurses made decisions increased (Banning, 2007). Student participants spoke about their reflection on their decision-making process, decisions made, and actions taken. Dreyfus and Dreyfus call this "deliberative rationality" (Dreyfus & Dreyfus, 1996: 43), a type of contemplation which is detached and meditative, unlike the "calculative rationality" exhibited by a novice, advanced beginner or competent individual (Dreyfus & Dreyfus, 1996: 43).

It is clear from my findings that students go through various stages of transition in their learning process; from the beginning of their training to their qualification as autonomous practitioners.

Each stage is characterised by distinctive cognitive structures from information gathering, knowledge encapsulation and information processing to knowledge application involving higher order thought processes. This is based on the cognitive model of information processing (Crespo et al., 2004) where there are different ways in which knowledge is produced and actions are performed during different stages in the development of a skill, in this case, critical thinking skills. There are differences between each stage in the developmental process, which are both quantitative and qualitative (Crespo et al., 2004), hence the measurement of critical thinking must include a qualitative element in assessment processes. Thus far critical thinking tests have solely focused on the numeric evaluation of the use of cognitive skills (Simpson & Courtney, 2002). However, for critical thinking to be actualised, a student must be able to demonstrate the cognitive skills and the affective dispositions; together these two aspects contribute to critical thinking measurement. Critical thinking measurement, therefore, cannot be entirely cognitive and numerically measurable; it must include qualitative assessment. This is justified by Cise et al. (2004) who conducted numerous tests on students on their Baccalaureate of Science Nursing students. The quantitative measurements rendered their results inconsistent, and inconclusive at measuring critical thinking skills in their students. Thus, following the frustration of having multiple episodes of inconsistencies in using assessment tools, the lack of the ability to see reliable pre-test and post-test measurements, coupled with the inability to make curricular changes based on the results, they steered their thinking towards qualitative methods of evaluation. They decided to use a qualitative questionnaire as a self-reflection tool, based on Facione and Facione's (1996) set of cognitive characteristics, to explore critical thinking development in their students. Cise et al. (2004: 151) concluded that the qualitative self-reflection tool helped "overcome the limitations of quantitative measurement by its concept specificity and applicability to nursing situations."

The findings additionally revealed that student participants' self-awareness impacted on their self-motivation. Self-motivation, according to Pintrich (2002), involves judgment of their ability to undertake a task, i.e., their self-efficacy and their inherent goals for undertaking a task. In the case of university learning, it might relate to attaining a good grade in an assessment. A person's motivation is what is going to get them performing at a high level. There, therefore, are important links between students' motivational beliefs and their knowledge and cognition. Similarly, just as one needs to develop self-knowledge and self-awareness on their knowledge and cognitive abilities, one also needs to develop this in relation to their motivation (Pintrich, 2002). This links in well with one of the dispositions of critical thinkers. Although they may possess the skills of critical thinking, if they do not possess the inclination towards it then critical thinking will not take place. Their inclination to use their skills depends on their

motivation and autonomy. This is where learner autonomy is important (See Section 2.8, p. 48). According to Elekaei et al. (2016), a relationship exists between learner autonomy and critical thinking ability. They describe learner autonomy as the ability of learners to make their own choices where they take responsibility for their learning. Learner autonomy depends on similar attitudes and dispositions as those of critical thinking. Students inclined towards a greater degree of learner autonomy are more motivated to learn and show a stronger tendency to use their critical thinking skills (Elekaei et al., 2016). The student participants recalled in their experience of learning that some students are motivated and engaged whilst some expect spoon-feeding. See Chapter Seven for more discussion on this point.

6.3.1. Summary

In this section, a theoretical discussion, in relation to participants' perceptions of the development of critical thinking, is presented. In addition, I present a reflective extract from a student participant regarding the growth in her critical thinking ability, knowledge, understanding and autonomy as a student radiographer, as follows:

> *In the first year, everything is new, and you cannot see the impact because the theory and the practice appear as two separate things. You are also just doing what you are told. In the second year, it starts to make sense because you can mix up your information and see how one thing relates to another and can now see the full picture. And now in year three, you can justify your reasons confidently and that makes a big difference from asking other people.* (Isla-IV3)

This data extract captures the development of learning from year one to year three in a typical student's progression on the programme. Overall, the greatest growth in their critical thinking abilities were evidenced during the second and third phase interviews, adding value to Fesler-Birch's (2005) statement that critical thinking develops over time through guidance and experience as opposed to during one lecture or teaching session. The table and model of critical thinking development, derived from the findings, is presented below.

6.4. Model of critical thinking development in diagnostic radiography

This section presents a progressive model of the development of critical thinking. Participants' perceptions were based on their increasing cognitive and affective understanding of the requirements for critical thinking, its application and implications, both in the university and clinical practice setting. The qualitative exploration of radiography students' and tutors' perception of the development of critical thinking is both novel and unique to diagnostic radiography education and training and makes an original contribution to knowledge and

practice. The model illustrating the development of critical thinking in diagnostic radiography over the three-year programme period is presented in Figure 7.

Metacognitive understanding of critical thinking

Independence

Year Three
- More advanced subject knowledge and clinical experience – undertake examinations of greater complexity and responsibility in being trained to work as qualified radiographers using critical thinking in their prioritisation of examination requests, image interpretation and commenting
- Dealing with challenges of graduate practice, e.g. night shifts and seven-day working
- Greater ethical understanding
- Less supervision support
- The shift from scaffolded learning to consolidated novice-to-expert understanding in preparation for autonomous graduate practice
- Greater confidence compared with year two experience
- Metacognitive understanding of critical thinking as a result of deeper levels of reflection and reflexivity

Recursive learning due to increasing complexity of examinations alongside scaffolded support from clinical mentors

Year Two
- Increased subject knowledge and experience from university and clinical placement learning compared with year one
- Undertake more complex radiography, using specialist imaging modalities, e.g. CT imaging on non-ambulant patients, e.g. wheel-chair, trolley, mobiles and theatre
- Increased ethical awareness
- Less direct clinical supervision support compared with year one
- Motivated by clinical mentors and tutors
- The beginnings of critical thinking development through reflection

Little to no knowledge of critical thinking

Year One
- New to university with no experience of clinical placement at the time of interview
- Basic subject knowledge and experience from university and clinical placement
- Undertake examinations on ambulant patients using plain film radiography, and gained experience in performing a range of examinations involving the appendicular and axial skeleton, chest, abdomen and pelvis
- The beginnings of ethical awareness
- Direct clinical supervision support
- No expectation of critical thinking skills development at this level

Dependence

Figure 7. A model of development of critical thinking in diagnostic radiography over the three-year programme period.

Figure 7 demonstrates a model of critical thinking development where the learning in Years two and three is recursive rather than linear with regular episodes of regression when new radiographic techniques and procedures are first introduced. Regression fades as new techniques are practised and eventually internalised with the scaffolded support from clinical mentors. This backwards and forwards, shifting nature of learning is a characteristic feature of the students' learning process across these two years.

The findings from year one revealed that students, being new to the university, did not have experience of clinical placement at the time of the interview, hence their inchoate understanding of critical thinking at the time. In addition, critical thinking is not a requirement

at Level four. Clinical placement learning focussed on working with routine patients for routine appendicular and axial examinations.

The findings from year two revealed that students developed an increased level of knowledge and understanding stemming from greater university and clinical placement learning compared with year one. The beginning of critical thinking development has been evidenced through reflection-in-action working through more complex examinations at placement, less direct supervision, and feedback from both radiographers at placement and tutors at university.

The findings from year three revealed that the students gained more complex knowledge and understanding stemming from more advanced university and clinical placement learning. The consolidation of learning was seen through more opportunities at independent working compared with year two. The model depicts students' development from having a basic understanding of critical thinking in year one to a more pronounced metacognitive understanding in year three.

This model is not the final word on the matter; it is rather a progressive model whereby although the participants have evidenced learning over time, their learning will continue to grow and evolve as they embrace the world of practice as diagnostic radiographers. There is virtually no literature on the development of critical thinking in the published domain, which makes this study, and the resultant model, a unique contribution to radiography education and training. The shades within the figure itself depict the students' progression from a less secure (dark blue) understanding of critical thinking in the first year to an increased level of understanding (less dark) in the second year to a more pronounced understanding (lighter blue) in the third year, indicating their professional development. Dewey (1991) states that for thinking to take place, a person must have knowledge or experience about the something that needs to be thought about. But, he says:

> *"unless there has been experience in some degree analogous, which may now be represented in imagination, confusion remains mere confusion. Even when a child (or a grown-up) has a problem, to urge him to think when he has no prior experiences involving some of the same conditions, is wholly futile"* (Dewey, 1991: 12).

This has similarities with writing from authors such as Glaser (1941), McPeck (1981), Ennis, (1989) and Facione (1990) who profess that for thinking to take place there must be knowledge of the subject. For example, radiography students will not be able to apply critical thinking skills to evaluate a radiographic image if they had not first been taught the radiographic features of the image. Furthermore, the model has a social constructivist underpinning,

especially in relation to the scaffolding of learning seen from Level four to Level six. This movement occurs in what Vygotsky (1978) calls the 'zone of proximal development': it occurs as a result of the learning through social interaction with radiographers, tutors, and peers. Although most learning appeared to have taken place with social interaction from radiographers, tutors, patients and fellow students, learning also took place through independent, personal actions of the students. The students demonstrated recursiveness in their development because each time a piece of learning, that could be a new technique or new situation, was presented to them in the clinical setting or university, they went back to a greater need for dependence before they could go on and become more proficient in that area. The whole of the developmental process is dynamic. By this I mean that their development was not a linear trajectory; it shifted backward and forward as they developed from having a basic understanding to a deeper understanding. The scaffolding of learning from radiographers enabled this recursive development thus moving students from dependent to independent practice. According to Vygotsky (1978), learning is a continual process from one intellectual level to a higher level. This learning development is seen through the increasing complexity of examinations and assessment that students have undertaken at each progressive level of the programme. Thus, the model of critical thinking development is based on the constructivist model of learning development as well as Bloom's taxonomy of the cognitive and affective domains. The model, therefore, embodies the theories of Bloom, Vygotsky, Bruner, and Piaget.

6.4.1. Summary

In this section, a model of critical thinking development in diagnostic radiography has been presented, taking into account the progressive and continual development of students through each year of study on the programme. Learning is a continuous process; this framework lays the foundation for the life-long learning that students will be required to undertake as graduate practitioners.

6.5. Chapter summary

In this chapter, a theoretical discussion, in relation to my first and second research questions, has been presented. A definition framework of the meaning of critical thinking is suggested along with a model depicting the development of critical thinking based on participant responses.

The next chapter presents a discussion of the challenges raised by participants, and the ensuing pedagogical implications for diagnostic radiography education and training.

Chapter Seven

Pedagogical implications for education and training

7.1. Introduction

In this chapter a discussion of the main challenges faced by participants in the development of critical thinking, as identified in Chapter Five, are presented. Key messages emerged from the findings of each interview phase which appear similar with no substantive differences. In addition, despite the clear evidence from my sample in relation to the model of development that was derived from the findings, there are significant dilemmas with the student cohort body as a whole. In fact, during this academic year (2017-18) the performance in critical thinking elements of assessment is even lower than in previous years (See Chapter One, p. 12). Although student participants have gained non-linear, recursive and dynamic curves of development in terms of their understanding of the meaning and development of critical thinking, there remain significant challenges for the programme in producing autonomous critical thinkers at the end of the training period. There are therefore pedagogical considerations which have implications for radiography education.

7.2. Developing a shared understanding of critical thinking skills

The tutor participants in my study understand the importance of developing critical thinking skills in their students due to its relevance to all aspects of a student radiographer's life and practice. The findings reveal that although students are developing this skill, it is not to the high level that tutors expect, so there exists the 'hidden curriculum' whereby students are expected to demonstrate high levels of critical thinking, yet there is an absence of specific learning and teaching activities to develop this high-level expectation. The failure to teach critical thinking will lead to an environment being "governed entirely by protocols and automated decision support" leading to diagnostic errors (Huang et al., 2014: 100). The authors conclude by asserting that diagnostic errors in healthcare may become a daily reality if we do not teach our students to think. This is indeed a concern for radiography students due to the expectation of autonomous practice, as previously identified. In their study involving high school science students, Miri et al. (2007: 367) found that if tutors "knowingly and purposely teach for promoting critical thinking skills" development in students, there are good chances of success. However, tutors require more help in developing their own skills in critical thinking so that they can be sufficiently prepared to teach students (Kuhn, 1999). Miri et al.

(2007) recommend professional development programmes for tutors to enable them to better understand the requirements for higher order thinking so that they can adequately conceptualise critical thinking in a more coherent way, which will help them in their consequent instruction of students. Williams (2016) suggests that universities focus on promoting their values, yet they want students to demonstrate obedience, rather than critical thinking. William's authority on the matter derives from a higher education culture involving several institutions whereas as a researcher, my experience involves one specific institution. From my experience, I do not feel that William's statement wholly applies in the case of radiography students. However, I concur that the university promotes its values and expects conformity but, as tutors, we also expect demonstration of critical thinking.

Lipman (1995) argues that if critical thinking can produce an improvement in education, it will be because it increases the quantity and quality of meaning that students derive from what they read and perceive and what they express in what they write and say. Critical thinking skills develop over time as a result of a range of experiences until they crystallise as part of the individual (Panettieri, 2015). Radiography students need time to develop the "inquisitive and ruminative aspects of critical thinking" (Price, 2015: 49) that are required in academic environments. From the findings, there is no doubt that critical thinking instruction needs to be more effective than what is currently happening. This is a key point in radiography education as students often are unable to apply their knowledge in sufficient depth and breadth. Consequently, feedback to radiography students often highlights a general paucity of critical analysis in their coursework. The aim of feedback is to help close the gap between what is understood and what is aimed to be understood. It serves major functions like helping students to scaffold their learning and facilitate learner autonomy as they integrate into a new academic culture (Sanchez & Dunworth, 2015). The authors further postulate that students must be active participants in the feedback process; to see the process of feedback for what it is rather than a product and acknowledge that learning takes place over time. Taking an active role in their learning develops their autonomy as students (Biggs, 2003).

In their study involving university students and staff from three different disciplines, Sanchez and Dunworth (2015) found that students' views differed from tutors' views regarding the purpose of feedback. Students in this study expected tutors to "provide answers to an already given set of problems. For example, 'I want you to tell me what you want me to write to get a good mark,'" whereas the tutors, like the tutor participants in my study, felt that feedback should give "pointers to knowledge seekers" (Sanchez & Dunworth, 2015: 465). As tutors, we give students feedback points, such as 'greater exploration of this topic is required here', or 'more analysis or evaluation of your points will have helped.' In addition, tutors give specific

detail on how students can improve their writing. This differs between Levels four, five and six depending on the assessment criteria. What we are doing though as tutors, is modeling Bloom's taxonomy by giving guidance on what students must specifically do to get to a higher level of analysis. The guidance comprises of points to make their writing more coherent, more analytical, and enable it to make more sense. So, through feedback, tutors are giving students a model of critical analytical writing. Some students, therefore, have perceived this as, *"just by following feedback guidance my grades have improved,"* (as stated by a student participant). Although Castle (2009: 76) suggests that more emphasis needs to be placed on "teaching, assessing and feedback on specific dimensions of critical thinking" skills, Boud (2000, in Nicol & Macfarlane-Dick, 2006: 200) argues that students cannot become independent, self-regulated learners expected to actively construct their learning if feedback is "exclusively in the hands of the teachers." Students require the opportunities to discuss feedback, as identified by the student participants in my study, in order to regulate their performance and, taking up those opportunities depends on their motivation and beliefs (Nicol & Macfarlane-Dick, 2006). As described above, the way in which feedback is currently provided appears to offer a good platform for active engagement of students; but the manner in which feedback is written does not require the active engagement of students. If active engagement is what we seek as tutors, this leads to the following consideration: do we as tutors need to take another look at how we write and provide feedback, and perhaps consider who writes the feedback? Should it be the tutor, the student or a peer, as suggested by Nicol and Macfarlane-Dick (2006)? The role of a tutor in facilitating active learning of students through feedback needs greater consideration (Biggs, 2003; Nicol & Macfarlane-Dick, 2006).

The pedagogical instruction and skills of academics are of paramount importance in developing this skill in students (Kowalczyk et al., 2012). These authors explored the critical thinking ability of college tutors and found there was a gap between what tutors understood critical thinking to be and their ability to promote this in the classroom. My findings are in accord with this; although tutors could articulate their understanding of critical thinking, some tutors indicated that they found critical thinking difficult to explain to students. In addition, some tutor participants thought it was a hard skill to develop. Could a possible reason for this be that not every individual possesses this skill as Panettieri (2015) argues, or could it be as Kuhn (1999: 18) explains, that tutors have been "offered remarkably little" information and examples as to what the skills are? Kuhn also argues that this is the reason tutors are unsure of "what forms they take, how will they know when they see them, and how might they be measured?" (1999: 18). If either is the case it is no surprise then that tutors struggle to explain the requirements of critical thinking in their feedback on critical analysis in university assignments, in a way that students understand. It is additionally no surprise that inconsistent guidance

appears to be given to students. It is imperative, therefore, for this shared understanding of critical thinking skills to develop so that tutors are able to adequately guide students.

7.3. Developing an explicit critical thinking curriculum – aligning learning, teaching and assessment

Participant responses revealed that although teaching and learning activities, which are perceived to develop critical thinking skills in students, are offered on the programme, these are occurring implicitly rather than explicitly. There is, therefore, scope to consider a greater dimension of opportunities for development of this skill within teaching and learning practice. Participants felt that scenario-based case studies, involving discussion with fellow students, would help more in the development of critical thinking skills. They also felt that tutor feedback was a valuable learning tool. Acting on feedback following conversations with tutors would thus help to develop critical thinking skills. Although learning through university feedback was perceived by the participants as being helpful in generating more thinking and discussion, clinical placement was acknowledged as having provided the most scope for learning and developing critical thinking skills. Furthermore, student participants said that *"more opportunity for debates and getting involved in 'sticky' discussions"* would help. 'Sticky' here implies debates on topics that would generate good quality discussion with diverse opinions: for example, scenarios that involved ethical dilemmas and moral issues where each student is certain to have their own viewpoint and where a number of patient and clinical factors need to be taken into account.

Teaching methods that can be used to develop critical thinking abilities, offered by Sommers (2013) and Chan (2013), include role-play scenarios, simulation activities, case studies and reflection activities that have been used in nurse education. Simulation activities provide particularly valuable insight by transferring textbook knowledge to typical real-life situations that students are likely to encounter within the clinical setting (Chan, 2013). In addition, Fesler-Birch (2005) posits that concept analysis, problem-based learning tasks, the Socratic questioning method, thinking instruction, and contextually specific metacognition instruction, are useful techniques to understand critical thinking and how it is to be used and developed. Socratic questioning and dialogical discussion have been published as a helpful pedagogical means of engaging students in the subject matter so that learning occurs as a consequence of questioning and finding solutions, alternatives, examining inferences and so on (Paul, 1990). Students also learn about intellectual discipline and thoroughness in pursuing a line of questioning in their search for the right solution, and over time, learn the power of logical

thinking and reasoning (Paul, 1990). From my experience as a radiography tutor, most students feel uncomfortable with asking and answering questions in a large class environment.

Fesler-Birch (2005) suggests open-ended Socratic questioning to facilitate students' reflection about the decisions they make so that those are based on reliable evidence. The method that Socrates used to question his subjects could be perceived as having injected an element of criticality into their thought process (Benson, 2006) in order to answer the question: a learning point that cements much of what we are expected to do today as autonomous radiographers. In addition, Paul (1990) asserts that pedagogically, Socratic questioning is a powerful method of promoting critical thinking through rational questioning and dialogue between teacher and students. This implies that students' critical thinking skills can be developed through skilled questioning by teachers. Teachers though, have to be trained to ask appropriate questions that direct students' thought process in order to raise their standard of thinking (Sahamid, 2016). One wonders as to what advice Socrates would have given to radiography lecturers wishing to extend their skills in questioning. In clinical radiographic practice, however, due to the nature of the clinical scenarios where there is often more than one option, there is unlikely to be a single response answer to questions. Students, therefore, have to be trained to consider multiple options in relation to how they would apply their knowledge depending on the situation (Kost & Chen, 2015). Socratic questioning methods, therefore, appear to be an instrumental strategy to aid critical thinking and questioning.

As tutors, we can teach the skills of critical thinking but, according to McPeck (1981), critical thinking *per se* cannot be taught. I agree with McPeck since critical thinking is a deep thinking process thus cannot be taught. The component skills of critical thinking, such as questioning skills, however, can be and should be taught just as other skills are. By developing these skills students will be able to refine their thinking process thus enabling the development of critical thought. However, Paul (1990) postulates that students' skills of questioning, arguing, analysing, and having open discussions on other people's points of views, are underdeveloped. This thus restricts their motivation and ability to mature intellectually and morally in a democratic world. Students need to be taught about asking specific, prudent questions and when to ask a question. It should not be a case of teaching about questioning for the sake of questioning. This is of particular importance as Edwards (2003) argues that dealing with complex patient cases, involving ethical and moral dilemmas, requires engagement in high-level questioning. In order to ask critical and facilitative questions, one needs to develop the skill of reflection in order to apply "reflective scepticism" (McPeck, 1981: 7). It is therefore important that students' reflective abilities be developed to a high standard, in order to develop their critical thinking skills (McPeck, 1981). Paul (1990) advises tutors, in

general, to consider more realistic and suitable approaches in their teaching practice to enable students to question ambiguity and complexity in order to develop high-level questioning skills. Teaching and learning exercises that foster critical thinking development were not explored as part of this study. However, from participant responses it is clear that the current teaching and learning activities do not explicitly address the requirement of the development of this key skills-set, hence the reason for including examples of what to consider in terms of teaching and learning instruction.

Kowalczyk et al. (2012) state that diagnostic radiography lags behind other professions, such as nursing and medicine, in adopting critical thinking approaches to teaching. This could be due to the large amount of content that needs to be taught hence less emphasis on analysis, synthesis, and application of knowledge. In addition, they report that tutors find it difficult to develop teaching methods that cultivate critical thinking skills in students and are somewhat resistant to change their teaching style. This is interesting empirical evidence from their study conducted on deans and directors of nursing programmes. Tutors' teaching styles were however, not explored in my study. Castle (2006) advises that tutors should carefully consider their teaching philosophy in order to positively influence students. In so doing, as tutors, we will be shifting the focus from tutor–centred to student-centred teaching, as discussed above. Tyler (1949, in Biggs, 2003: 25) assures tutors that "learning takes place through the active behaviour of the student: it is what *he* does that he learns, not what the teacher does", where '*he*' is the student. This structured set of skills can be added to complete critical thinking tasks to make learning objectives more specific and focussed on guiding the development of critical thinking skills in students.

Another challenge emerging in relation to learning and teaching activities is the implicit link between learning and teaching activities and the skills they are designed to develop. Although the findings indicate that there are learning and teaching activities, which do engender critical thinking skills development, there is evidence to suggest that we, as tutors, do not make the link with critical thinking skills explicit within those activities. Making this explicit will foster a deeper engagement with knowledge and understanding in students' decision-making process and may help with the development of metacognition (Fesler-Birch, 2005; Panettieri, 2015). This is clearly an area that needs addressing in terms of curriculum design. Tutor participants agreed that teaching methods should be focussed on developing critical thinking skills and the fact that this requirement is so implicit rather than explicit within the curriculum means that it could get lost. They stated that in a large class of diverse learners, the multiplicity of learning styles means that 'good' students will take the initiative and get on with their learning regardless of whether it is in the curriculum or not, while others will need more encouragement.

In terms of good practice and inclusion we need to consider the remaining students who are not considered as 'good students.' What should be done to address this? Is it sufficient that we accept that critical thinking is implicit within the curriculum whilst we explicitly assess it? Students' performance, according to pre-defined competency criteria, is explicitly assessed during formal assessments. If students are developing the skills sufficiently without the overt teaching of those skills and considering that radiography students struggle to develop and apply the skills for higher order thinking, there therefore needs to be more "explicit constructive alignment of the curriculum and more transparent links between learning and assessment" to improve students' development of these skills (Castle, 2006: 89). Although critical thinking is not an outcome at Level four of the degree programme, students have demonstrated that they developed this skill at a low level in their assessment involving the justification of X-ray examination requests. Tutors need to ensure, therefore, that the curriculum at Level four prepares students for this expectation by offering appropriate teaching and learning exercises that develop the component skills of critical thinking at this level.

Furthermore, guidance given to students has in the past comprised of only the cognitive skills of critical thinking, for example, the skills of analysis and evaluation. From the findings, it is evident that critical thinking involves more than just the cognitive domains of thought: it involves the affective domain as well. This is essential to the safe and caring practice of diagnostic radiography. Guidance on critical analysis given to students, therefore, must include both the cognitive skills and affective dispositions of critical thinking (Panettieri, 2015), in relation to diagnostic radiography.

7.4. Developing shared clinical placement learning

Students in my study cited challenges in being able to apply their learning within the clinical environment where they were expected to follow instructions without questioning information. This possibly stems from the traditional instruction-led practice of radiography where a radiologist was the only decision-maker, as discussed in Chapters One and Six. As a result, radiographers have traditionally felt "inferior and subservient" to radiologists and had experienced feelings of low self-esteem, intimidation, under-appreciation, and worthlessness as reported by Yielder and Davis (2009: 348). From my personal experience as a radiography student having trained in the late eighties, I too was socialised into a culture of conformity where training valued discipline, obedience, and respect for authority. I still remember that feeling of being reprimanded by a radiographer for suggesting that the X-ray beam be collimated further to reduce the radiation dose to the patient. From the students' responses in my study, it appears therefore that some of them are being subjected to a similar kind of

socialisation in today's workplace. If this is the state of the workplace today, then it is no wonder that our students have a reluctance to question and challenge poor practice. Could this be representative of the current workplace culture steeped in fears of new ideas hence the resistance to change? This study did not explore the current state of play of radiology departments within the NHS, however, if this is the current culture of working, this will significantly impact on students' development of critical thinking skills, and their preparedness to undertake autonomous radiographic practice.

Although the education, training, and scope of practice of diagnostic imaging have changed, we are faced with the dilemma of a theoretical evolution versus a vocational evolution. There was an acknowledgment, within the findings, of how practice has evolved over time from being a previously instruction led profession to an autonomous one as it is today. Tutor participants in my study felt passionate about ensuring that their teaching practice did not inadvertently set students up to fail as practitioners. This is important because students will be qualifying as autonomous practitioners and need to be able to answer questions and justify their practice based on their knowledge and experience. It is also about working to best practice so that mistakes are avoided because of a lack of low levels of critical thinking. Teaching students to apply their radiographic knowledge would prove invaluable to them especially in lone working circumstances, for example, during shift work when there are no radiographers or senior staff members present to discuss options with them. They must trust their own judgment and learn to justify and defend their decisions as expected in graduate autonomous practice, in all aspects of service delivery and patient care. Choosing the correct imaging pathway in order to manage patients is just one of the many complex areas of radiographic practice where critical thinking skills are of paramount importance. Critical thinking in radiography, therefore, involves more than just the implementation of protocols associated with a standard range of radiographic examinations (McInerney & Baird, 2016), and tutors need to go beyond the task-oriented learning approach in order to develop critical thinking skills in their students (McInerney & Baird, 2016). An autonomous practitioner works on a very high functioning level of problem-solving on a daily basis. It is the responsibility of the university to prepare students to apply elements of critical thinking in their radiographic practice. The development of students' critical thinking skills has significant ramifications for leadership and other aspirational roles within the future of diagnostic imaging practice (Yielder & Davis, 2009). As a direct outcome of my findings, a Level six module focusing on autonomous decision-making in radiography forms part of the newly approved training programme which begins in September 2018. In addition, the new radiography training programme has been designed to introduce students to higher order thinking skills from Level four and will build on this in a developmental way as they progress from Level four to Level six.

Furthermore, tutor participants in my study expressed that they are not involved in the clinical learning of students. Thus, greater involvement on their part would help close the theory-practice gap. Chapters Four and Five indicated that there was a clear development of critical thinking which was evidenced in students' clinical placement learning cementing the fact that clinical placement has been pivotal in their development. Findings from my study influenced the implementation of a weekly clinical link tutor visit to students. The purpose of this initiative was to further support student learning at placement, and support radiographers by providing mentor and assessor training for them on-site. The weekly clinical link tutor visits have already yielded satisfactory feedback from students, supervising radiographers and radiology managers. Although not without its problems, this implementation will foster a stronger working partnership between the university and clinical placement settings to ensure a seamless transition of learning.

The findings demonstrated students' learning changes during clinical placements. The various demands placed on them in their respective levels of learning facilitate those changes in keeping with Schön's (1991) reflection in and on the action, and Kolb's (1984) reflective cycle which enables them to learn from their experience of working in the practice environment. Kolb (1984: 38) called learning a "process whereby knowledge is created through the transformation of experience," the process of which is continuous, not just in an educational sense but in a person's everyday life, where they are expected to make decisions or solve problems. This will go a long way into developing student radiographers as life-long learners. Through student responses, the findings indicated that radiographers were unknowingly modeling the scaffolding method of knowledge creation in their contact with students during clinical placement. A recommendation would be to make the scaffolding method of clinical learning an explicit teaching method to radiographers supervising students in a clinical environment. There are several well-known theories on learning that support the idea of scaffolded learning, experience and meaningful thinking in relation to the learning of higher order thinking. For example, those presented by Vygotsky (1978), Piaget (1985) and Bruner (1986). The theories they present were briefly discussed in Chapter Three, pp. 54-55. The model of critical thinking development presented in Section 6.4, p. 162, demonstrates a constructivist, student-built understanding of their world. The model has highlighted areas to consider, such as the benefit of clinical education in developing critical thinking skills, and how this can be maximised and facilitated.

7.5. Student engagement and motivation

In my study tutors noted challenges with respect to motivating and engaging students with the learning activities: those who engaged in their learning benefitted from the experience. In addition, students agree with tutors that some of their peers do want to be spoon-fed information as explained in the extract below:

> *Many students on our course do want their hands held all the way through the course, without having to do too much thinking of their own.* (Student participant comment)

This attitude to learning affects their performance and progress on the programme. As a consequence, tutors are required to demonstrate additional support of these students, which, in my experience over the years, has taken up an extraordinary amount of time and was significantly challenging. One of the reasons for this imposed challenge was seen in implementing NSS priorities to improve student experience scores. This was considered by the tutor participants as detrimental to developing independent learners, resulting in spoon-feeding, and a negative impact on students' development of critical thinking skills. The process of critical thinking involves knowledge, skills, and dispositions and is much more valuable than the sum of its component parts. The process can be likened to the analogy: "if you feed a man a fish, he eats for one meal; if you teach him to fish, he feeds himself for a lifetime" (Paul, 2011: 176). In the same way, if we give our students the answers they are limited in their ability to sustain themselves; although we cannot teach students how to think, we can teach them to learn in order that they think well (Dewey, 1933). If we teach them the importance of thinking and give them ways to learn, they will be skilled to meet the never-ending demands of their education and practice. The spoon-feeding expectation by students hinders their independent learning and expectation of autonomous learning in higher education. Students expect tutors to be giving them all the information, which is relatively easy for tutors to do, however, the knock-on effect is that students are becoming less and less autonomous in their approach to learning as the spoon becomes bigger and bigger (Dunworth & Sanchez, 2016). As discussed in Section 2.8, p. 48, autonomous learners make autonomous practitioners. This, therefore, has wider implications for lifelong learning and practice in their lives as radiographers.

We have become accustomed to relying on other people's views and information rather than creating our own, which have been exacerbated by instant messaging, faster internet speeds and so on. Students are now positioned in higher education as customers obtaining a service (Dunworth & Sanchez, 2016), and as such learning has become a battleground with students demanding more and tutors trying to keep the 'customers' happy while maintaining academic standards. This means that academics now have even less time to explore innovative

pedagogical strategies than before, which ultimately impacts on the autonomy of a student learner and expectations for critical thinking development (Dunworth & Sanchez, 2016). In a student-centered classroom, the emphasis must shift from the product of thinking to the process of thinking; herein lies the essence of critical analysis. Herein, however, also lies the dilemma of product versus process, where greater emphasis is required on the latter rather than the former. In diagnostic radiography, due to the extent of subject-specific content that needs to be learned, tutors follow a largely knowledge transmission model of teaching rather than offer a constructivist-based approach (Miri et al., 2007). One of the barriers to developing and implementing new teaching methods, however, is the high instructional workloads of tutors where there is insufficient time to learn new strategies (Kowalczyk et al., 2012). Nonetheless, as tutors, we are advised to balance our time in the classroom with the need to deliver high amounts of content and incorporate teaching methods that foster inquiry-based learning (Kowalczyk et al., 2012). From a personal perspective, this is indeed a challenge to achieve within the expectations and constraints of academia.

A further challenge for tutors lies in motivating and encouraging all students, not only the ones considered as 'good' students. This is a key consideration for teaching and learning at university, however, I do not believe that this only applies to the radiography programme. From my experience of multi-professional teaching, it appears to be an implication for students in higher education in general. In relation to diagnostic radiography, we are training students for our profession and the profession itself has changed. We, therefore, need to look at those changes and the expectations they bring and train students to be able to meet those expectations. It is about being proactive in our responsibility in training the future workforce, and one of those responsibilities lies in ensuring that we, as tutors, are well equipped with the skills that we are required to teach (Castle, 2006; 2009).

7.6. Summary

In this section the key challenges drawn from the findings of the study that have pedagogical implications for the radiography programme, are presented. For students and tutors, the first step is to understand what critical thinking is and what skills are required for critical thinking to develop. An improvement in education would be seen in producing graduates who make a better workforce. Improvement here implies that students would be more independent learners requiring less academic support that we, as tutors, are currently experiencing. From the responses, it is evident that although student and tutor participants felt certain teaching and learning activities helped, more specific opportunities and practice were needed to develop critical thinking skills, with explicit links between those methods and skills development. The

tutor participants noted challenges with respect to student engagement and motivating students with the added complexity of meeting HEI imperatives such as providing a good student experience. The key overall implication for education and training is the impact of learning on the development of the autonomous radiography practitioner.

Having considered the pedagogical implications for the radiography training programme, the next chapter presents a reflexive account of my position as researcher, tutor and programme leader.

Chapter Eight

A reflexive account

8.1 Introduction

In this chapter, I present a reflexive discussion of my roles as tutor, programme leader, senior colleague, and researcher. Through my reflexivity and reflection, I acknowledge the power relations that exist when conducting qualitative research, in particular, the insider-outsider dimensions of the researcher role. I also provide an explanation of the actions taken based on my reflexivity.

8.2 What is reflexivity and why is it important in my study?

In order to understand the requirements of reflexivity, it is necessary to explore its meaning. Finlay (2002: 532) describes reflexivity as "thoughtful and conscious self-awareness." Like Finlay, Pillow (2010: 176) describes reflexivity as "increased attention to researcher subjectivity in the research process, with a focus on how does, 'who I am, who I have been, who I think I am and how I feel,' affect the data collection and analysis" process. Lastly, Etherington (2004: 19) sums up the meaning by exemplifying that "to be reflexive we need to be aware of our personal responses" and be able to make choices about how we use them. We also need to be aware of the personal, social and cultural contexts in which we live and work, and to understand how these impact on the ways we interpret our world. The process requires self-awareness of the dynamics between ourselves and our participants, as well as the actions and interpretations at all stages within the research process (Etherington, 2004), or "methodological self-awareness" as Finlay and Gough (2003: 4) call it. In heeding the advice of these authors, as the researcher, I need to understand the impact of my position throughout the conduct of my study and engage in critical self-scrutiny. This is based on the belief that researchers cannot be distant from the knowledge that they are generating (Mason, 2002). I, therefore, had to exercise self-awareness throughout the research process through consistent questioning of my subjectivity and objectivity as an internal dialogue with myself. Giorgi (1994: 205) reveals that "nothing can be achieved without subjectivity" and "objectivity itself is an achievement of subjectivity." However, familiarity with research participants can lead to a loss of objectivity particularly in relation to assumptions based on a researcher's previous experience or prior knowledge (Breen, 2007). Acknowledging this position is a significant aspect of reflexivity as a researcher due to the complexity of insider research where questions about "objectivity, reflexivity and authenticity" of research projects are raised (Kanuha, 2000:

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444). However, Breen (2007: 169) cautions that one should not be "naïve" in thinking that "minimal exposure to the research context would automatically reduce bias." She questions that from a "constructionist perspective", where knowledge is being generated, can "bias ever be truly eliminated?" (Breen, 2007: 169).

In qualitative methodology, a researcher is closely related to the data collection and analysis (Dwyer & Buckle, 2009). Unlike the power relation of the positivist researcher-participant dichotomy, the qualitative researcher-participant power relationship is a continuum which develops and changes as the research progresses. On one side of the continuum, there is a high level of partnership whereby research findings denote strong loyalty and commitment to participants and their stories. And on the other side, the relationship is differentiated and asymmetric, due to the data being transferred to a researcher and the researcher processing and interpreting the data without active input from a participant (Karnieli-Miller et al., 2009). The practice of reflexivity is therefore significant in ensuring that the research conducted is trustworthy in relation to its credibility, dependability, confirmability and transferability (Lincoln & Guba, 1985).

8.3 Positioning myself as researcher

A deep learning approach was fostered in me when growing up in South Africa, in a well-educated, open-minded family. My family lived in a society that considered education to be a steadfast discipline. What came with this was a culture of reading and questioning rather than blindly accepting information given to me. In addition, I have a background in diagnostic radiography and practiced for many years before entering academia. My upbringing in South Africa and healthcare training in both South Africa and the UK, instilled in me a strong sense of professionalism with strict values of what is perceived as right and wrong. These values were infused in all aspects of my conduct of this study.

During my undergraduate education and training journey in South Africa, as students, we were not spoon-fed information. Instead, we were expected to retrieve it ourselves. Even though we did not appreciate this at the time, this independent learning culture kept us sufficiently enthused and engaged during our student years. In comparison, within my role as a principal lecturer and programme leader in higher education, I continue to find my students' motivation and engagement with their learning surprisingly low. I have often wondered why there appeared to be a lack of motivation to succeed in what they were doing despite having made the conscious choice to attend university. This created an interest in understanding why it was that students appeared not to want to 'go that extra mile' in improving their written

assessments. It bothered me over time that students seemed happy to receive similar feedback comments in relation to their written assessment year on year but did not appear to make much personal effort to improve in order to receive better feedback in future assignments. Furthermore, it concerned me that as tutors we were giving feedback comments on the same area, such as 'more analysis of ideas required here', 'lack of critical analysis noted,' consistently over time. This was the trigger and issue of concern that led me down my chosen path of study.

8.4 My research diary

Central to my understanding of what was going on in my research study was the keeping of a research diary. This formed a key point of reference where I recorded notes, notations on how I digested the notes, and changes to my thought processes as they occurred at various points throughout my study. I also recorded reflections on how I felt following the interviews, my relationship to the participants, questions of ongoing interest, issues which puzzled me and the context of the study as it progressed. Keeping a diary was not a usual personal practice of mine. As a researcher, however, I noticed that my thoughts went back and forth to various aspects of my study, i.e. the literature I was searching and reviewing, the interview schedule, the participants' responses in my study, supervisors' guidance and thinking about what they would say about what I thought. In relation to the thoughts, I found that I was increasingly having internal conversations with myself. For example, if I read a paragraph in an article, it would bring to mind an extract from one of the participants, and I would find myself thinking about how the two are related, and whether there is something worth exploring within those connections. I would think those through and then my mind would be satisfied that I had given those thoughts due diligence and consideration. However, when it was time write it up, I would not remember the detail as clearly as I did when I first thought about it. This is when I began to change my habit by keeping a diarised log of my thoughts, in relation to the various aspects of my research study. The diary served as a useful reminder of my thoughts and feelings during the research process and aided my interpretation of the data. Noting and diarising my thoughts as they occurred was a fundamental step in acknowledging my various roles. This had a significant impact in "minimising the researcher effect" (Bonner & Tolhurst, 2002: 11) in my study. I was therefore transparent in relation to my experience and perspectives so that the researcher effect, in relation to my personal subjectivity did not in any way limit the robust conduct of my study.

8.5. Insider outsider dimensions of my various roles

Northway (2000) posits that in qualitative research it is not possible to separate the researcher from the research. I hold a senior position in my School and therefore cannot be separate from the institutional context within which I work. Qualitative research, unlike its quantitative counterpart, acknowledges this relationship and the practice of reflexivity, and therefore engages a researcher in a way which makes this reciprocal relationship explicit (Dwyer & Buckle, 2009). I had prepared myself for this experience. I therefore managed my thoughts and ideas in a reflexive manner. My research diary was kept close at hand during those times and I frequently noted down my thoughts. An extract from the diary is given below.

From my research diary:

> *Being a part of the institution in which the research was carried out meant that I could not bracket myself from the research or the participants. I am part of the institution and the reason I am conducting this study is to add value to the existing programme and hence the institution. Qualitative research allows me as the researcher to get close to my data.* (AR, December 2015)

My research is insider research, which has come about as a result of my personal experience working within a higher education institution. In relation to the participants in my study, I am their tutor, colleague, programme leader, and researcher. Because of my various roles, I was aware of the potential for power issues during all aspects of the research process. There are relationships within these roles and there are a number of factors that affect a researcher-participant relationship. Examples of such factors are the content of inquiry, the institutional context within which a study is being carried out and personal motivations of both researcher and participants, as posited by Karnieli-Miller et al. (2009). In addition, participants' motivation may have been influenced by the nature of the inquiry, the extent of their need to be heard or listened to, their willingness to help the researcher or their interest in the research outcomes and implementation. My roles as both an insider and outsider therefore were key considerations throughout the research process.

Dwyer and Buckle (2009) argue that whether a researcher is an insider, sharing common features or characteristics with the research participants, or an outsider who does not, the researcher is an indispensable facet of the study. Griffith (1998: 361) describes an insider as "someone whose biography (gender, race, class, sexual orientation, culture, etc.) gives them familiarity with the group being researched" while the outsider is a "researcher who does not have any intimate knowledge of the group being researched, prior to entry into the group",

similar to that of a continuum. Kanuha (2000) concurs with Griffith's description, by stating that insider researchers share an identity, language or experiential base with the study participants. This is true for my study as the common characteristic is the experiential base which is diagnostic radiography whereby the participants are students registered on my programme, and tutors who teach on the programme. Sharing this cultural understanding of a research topic with participants is an advantage to insiders (Bonner & Tolhurst, 2002), as the role status allows a researcher acceptance by research participants resulting in more open participation and the generation of richer data (Dwyer & Buckle, 2009).

Although role confusion can occur in any research study, Kanuha (2000) notes that there is a higher risk when a researcher is familiar with the research setting or the participants, in a role other than that of a researcher. I shared a greater rapport with my participants due to my familiarity with them. This allowed me to explore their experiences and gain deep insights into their worlds, though this did not mean that I had to agree with everything they said. For example, I sometimes referred to students and tutors as 'they' in my writing, however at times I found myself writing as 'we', especially in relation to the tutors. At these times, I acknowledged that I sometimes did not share participants' views, while at other times I did. This experience was an important acknowledgement that as the researcher you can have different opinions and perspectives to those of your participants (Breen, 2007), and being objective in how I analysed those responses helped to keep my interpretations honest and authentic. Furthermore, at times during the interviews, I thought about whether participants fully understood what they were telling me, or whether they were saying things to impress me as their tutor and course leader. In relation to the tutor participants, I thought about whether they were giving me 'textbook talk' because they too wanted to make a good impression. However, an advantage of being an outsider, according to Bonner and Tolhurst (2002), is that one can listen objectively without judging participants. Their responses in my study therefore were taken on merit rather than on the assumption that they sought to impress. Furthermore, insider researchers have been accused of being "inherently biased to be curious enough to ask provocative questions" (Merriam, et al., 2001: 411). They go onto state that an "insider's strength become an outsider's weakness and vice-versa" (Merriam, et al., 2001: 411). As a member of this group of participants I felt that I could not exercise what Merriam et al. (2001: 411) call "an outsider's advantage" and ask 'taboo' questions, due to having to work with the participants once the study was over. Narayan (1993: 679) states that acknowledging one's position "limits one's purview from these positions" and "undermines the notion of objectivity" in the belief that when one acknowledges their position, all understanding becomes subjective "based and forged through interactions within the fields of power relations." I experienced therefore the back and forth movement between insider and outsider roles. Although I was

aware of my own biases and objectivity in relation to the topic under study, I was also aware of my position in relation to my research participants, the university environment, and the associated advantages and limitations within these roles.

On one occasion when subjectivity as an insider crept into my reasoning process it reminded me of the fine balance between outsider and insider. Self-awareness and metacognition, however, kept the analysis of findings true to the context which participants intended. The following diary extract demonstrates my reflexive thought process in relation to a student participant's comment regarding feedback.

> *When participant X mentioned the poor value they placed on feedback in their first year, this made me feel disrespected as a tutor. Time and effort have gone into providing feedback to students within tight timeframes and here is a student who is not seeing the value or staff effort in helping them. As tutors we are bound to carry out certain duties, e.g. writing feedback in a certain way as we have to be seen to be consistent in how feedback is provided to all students. However, I must remember that we are writing feedback for students, as the audience. If they are unable to understand how to take their learning forward then no matter how much effort we put into writing feedback as tutors, it is going to be useless to students. As tutors, we need to explore their views on how we provide this feedback, in an objective manner. I need to consider this issue later on when I look at the pedagogical implications of the programme.* (AR, March 2016)

With my insider tutor and programme leader hats on, I thought that some of the comments, like the example in the extract above, were critical of staff effort in helping students. Hearing this as an insider was frustrating as writing feedback is often a lengthy process taking up extended periods of time. Students are saying that the feedback does not help them so they place little value on feedback. Although insider research enhances the depth and breadth of understanding phenomena, questions about objectivity and authenticity of a research process followed are raised because of a researcher's proximity to participants (Kanuha, 2000; Dwyer & Buckle, 2009). Furthermore, Asselin (2003) points out that the dual role of insider and outsider can result in confusion when a researcher responds to a participant or analyses the data from a perspective other than that of a researcher. As the researcher, stepping out of the insider role and looking from the outside in, revealed that something was amiss. There appeared to be a disconnect between how tutors perceived supporting students through feedback and what students saw as helpful feedback. Exploring the quality of feedback and how helpful students are finding tutor feedback is a clear area of pedagogical concern and has been considered in Chapter Seven. In relation to my roles however, my ability to pull myself from the insider tutor to the role of an interested researcher and look into the data with a different lens yielded a different perspective. My outsider role was able to see what the insider could not and render what Merriam et al. (2001: 414) call "a more objective portrayal

of the reality under study." However, they conclude that even though an insider's thoughts and understanding of a study will be different from an outsider, the latter's perspective is just as valid. Maintaining an up-to-date record of my thoughts in my research diary played a significant part in reminding me of how my thoughts were shaped by the nature of my different roles, and in how I managed this dialectical relationship.

A qualitative researcher's perspective, according to Maykut and Morehouse (1994) is a paradoxical one. They clarify that on one hand, it is to be acutely tuned in to the experiences and meaning of others, i.e. to 'indwell' and at the same time to be aware of how one's own "biases and preconceptions may be influencing what one is trying to understand," (Maykut & Morehouse, 1994: 123). Similarly, Dwyer and Buckle (2009) explain that being an outsider does not give researchers immunity against their personal perspectives. My potential biases included aspects of the process such as picking up only positive messages and aspects of the responses that I wanted to hear as the programme leader, and conversely not taking note of negative responses. At certain points, I felt as though I was open to the challenge of 'sweeping things under the carpet' as there were comments that were critical of the programme, as seen in the example above. I managed this by remembering that the whole point of actually undertaking a study of this nature was to enhance the current provision of training by effecting change in pedagogy and the learning of my students. Any criticism, therefore, was of great benefit to instigate changes to the training programme. Another helpful strategy was questioning my thoughts by asking myself: Is this my view as a tutor or the researcher; am I thinking as a tutor or the researcher? This metacognitive and self-interactive process aided my analysis as a researcher. In addition, without researcher skills of empathy, caring and understanding, posit de Laine (2000), a researcher becomes a detached observer. As the researcher, I needed to be as Dwyer and Buckle (2009: 59) state "open, honest, authentic and deeply interested" in my participants' experiences and "committed to accurately" presenting their views. I ensured therefore that a balance of views was presented in my analysis, not only the views that confirmed my argument.

Another important aspect of my experience was in discovering that on the one hand, the interaction with participants can create confidence and trust thus allowing me as the insider to appreciate the complexity of the social world (radiography programme) being discussed. Whilst, on the other hand, participants may not have wanted to share information with an insider for fear of being judged, colleagues may temper the truth in the knowledge that professional relationships have to continue after the research is completed (as identified earlier), and pragmatism may outweigh candour (Mercer, 2007). When interviewing my colleagues, who are tutors on the radiography course, I was perceived to be an insider as

there were certain topics which "engendered a greater degree of insiderness" (Mercer, 2007: 4), for example, the value of critical thinking abilities in clinical placement. Conversely, I felt that certain topics, such as those relating to teaching methods for developing critical thinking, resulted in a shift of rapport and rendered me towards the outsider end of the insider-outsider continuum. This is where perhaps tutors felt that I was 'checking up' on the teaching methods that they were using and making a mental appraisal of it. So, during the same interview, I felt like an insider on certain issues and an outsider on others. Conducting insider research is therefore like "wielding a double-edged sword" (Mercer, 2007: 7). From my experience, I feel that the very practice of reflexivity sometimes creates situations whereby you have to look within from the outside. Burns et al. (2012) affirm in their study involving midwives, that a researcher is unable to occupy either the insider or outsider positions fully during the course of their study. Rather they occupy what Dwyer and Buckle (2009: 60-61) call "the space between." 'The space between', challenges the dichotomy of the insider outsider roles and enables both insider and outsider positions through the adoption of a dialectical approach.

A retrospective reflexive analysis of my data collection process enabled me to make meaningful connections between theory and practice, and perhaps invoked a depth of learning that, like Watt (2007) says, may not have been possible through other methodological means. This is evidenced by the change made to the ordering of the questions within the interview schedule following the conduct of the pilot study (See Section 3.6.1, p. 64). I realised that I had to draw participants' understanding of the meaning of critical thinking out of them, by asking them a series of related questions which guided their thinking, rather than expecting them to answer the question, 'What do you understand by the term critical thinking?', at the beginning of the interview. The revised structure of the interview schedule enabled a more meaningful and natural flow of conversation. For example, participant responses changed from, *"...err um not sure about that really"* (when asked about the meaning of critical thinking at the beginning of the interview, to *"…critical thinking is about weighing your options…is influenced by a person's nature and nurture…"* when asked the same question towards the end of the interview. The structure of the interview questions gave the participants a longer time to think about the meaning of critical thinking. Hence, they were able to come up with some of their own tentative views. During some of the interviews, especially with the student participants, they then appeared to become like 'open-ended can openers' where they could not stop talking.

Another act of reflexivity was seen in my decision to include a case study of the development of critical thinking within my findings chapter. I had not planned on including a case study within my findings chapters, however through thinking-in-action I felt that it would be an

important and helpful addition to readers to demonstrate a student's progression from a naïve understanding to a deep, more pronounced understanding of critical thinking evidenced through her ability to describe her thought processes and demonstrate her development of critical thinking skills. Amelia's case study (See Section 5.5, p. 134) draws together the findings in relation to participants' understanding of the meaning of critical thinking and their development of critical thinking skills as they progressed from year one to year three.

Lastly, when I read the transcriptions following a reasonable period of time, I sometimes questioned myself thinking, 'Did I really say that?' This prompted further listening to the recordings and of course, the narrative made sense in the context of the discussion at the time of the interview. I am sure that participants may feel the same way when reading and reflecting on what they had said in the interview. As the insider I was also concerned about how the students, in particular, felt about participation in the study considering that this was a longitudinal study, and although their attendance at interviews demonstrated their commitment, I still wanted to hear their views. Students expressed their thoughts on the interview questions and on the value of their experience of participating in the study. Eight examples of responses are given below:

> *It made me think about how I look at things and understanding the way I look at things.* (Jacob)

> *It's been a good experience and I learned a lot about my thinking.* (Chloe)

> *I really enjoyed it and critical thinking per se did come to mind at times.* (Amelia)

> *It has definitely benefitted how I look at situations. I had never had experience of this at school before, so this was very new to me. It made me think more and the words critical thinking was a highlight.* (Olivia)

> *I always walked away from these interviews being totally confused but it has encouraged me to think deeply about what I do and think that 'I could this better in the future.* (Thomas)

> *… your questions have probed my thinking in a way I didn't expect. It was good in that it made me more aware of my thinking.* (Jack)

> *…it made me aware of how much thinking I do without realising it.* (Lola)

> *It made me think more about the difference between thinking and critical thinking. There is a massive difference between the two.* (Sophie)

The student participants were motivated by the study area which they thought was *"interesting",* and which could positively impact on their learning through its outcomes and implementation. These extracts affirm the students' positive experience of participation in the interviews and exemplify the importance of pedagogical research of this nature.

8.6 My research learning journey

Just as a researcher influences the social context in which his/her study is located, seen in my reflexive descriptions above, it is inevitable that the process of undertaking the research itself influences and to a certain extent, transforms the researcher in a reciprocal way. A few challenges were faced during the process leading to significant learning points that will influence my future research work. Firstly, an aspect of my own learning as researcher was learning to write in the first person. Coming from a health science background I was socialised into a culture of thinking that all research must be couched in the third person to be considered as 'academic.' My supervisors helpfully guided me through this writing journey. Furthermore, I learned that in undertaking a qualitative study in education and the social sciences, there is no 'right' way to follow. The norms and conventions I held took a long time to dissipate in order to realise the extent of flexibility one has in designing an interpretive study. I learned that in qualitative research there is no 'straight and narrow' and each comment that your participant makes has the potential to be explored further. In addition, there are no clear-cut recipes to undertake data analysis, even though helpful suggestions have been made by experts in the field (Miles & Huberman, 1994; Silverman, 2011). As the researcher, I had to engage with my data by reading it many times. It was the same approach with listening to the interview recordings. I knew what my participants were telling me; I could hear that clearly, but I remained unclear about what was that they were not telling me. How do I assess what it was that they chose not to tell me, due to my position of being their course leader, tutor and/or colleague? These questions were constantly on my mind during the analysis and writing up of my findings. I now fully understand the need and requirement to demonstrate rigour for the assurance of trustworthiness in all aspects of a research study of this nature.

The heart of qualitative research lies in the interpretation of information derived from the data and not the data itself (Miles & Huberman, 1994; Mason, 2002; Denzin & Lincoln, 2008). Researchers themselves play a very important role in how the information is interpreted. I was, however, aware of my position within the research at all times. It was this awareness that made the analysis and interpretation such a rewarding process. Analysis of data has been recursive involving the process of going back and forth between my data and my reading, as described above. With each reading, however, even if it is was something I had read before, this brought new knowledge and understanding to the reading giving me new insights (See research diary extracts in Section 3.7, pp. 67-71). In relation to trustworthiness, the ideas emerging from each interview set was checked at the following interview. When student participants returned their edits of the transcribed interview, I noticed that they had not commented critically on the content of the transcripts. Two students, however, focused rather

on the mechanistic aspects of their transcripts and made edits in relation to the use of grammar, typographical errors or punctuation misuse. It reminded me of the comments we suggest in our feedback to them as students. In addition, none of the tutor participants returned their transcripts with changes. It was therefore assumed that participants were satisfied with the accuracy of the content of their transcripts. Although time-consuming it was a worthwhile process getting respondent verification of the accuracy of the interview transcripts. Three examples of participant comments are given below:

> *I'm happy with that…*

> *Don't think any change is needed.*

> *Thank you…I have edited in a few places…*

This was also a helpful indication of a respondent verification of the early emergent themes of the study and contributes to the trustworthiness and confirmability of the themes. Koch and Harrington (1998: 884) state that "legitimisation of qualitative research is closely tied to success in demonstrating rigour." This study has been rigorously scrutinised using Lincoln and Guba's (1985) criteria to assess the credibility of the research process and the resultant findings thus assuring trustworthiness in my research (See Section 3.4, p. 58). Reflexive, objective self-critique, therefore, helps convey a message of honesty in a research process which is imperative in ensuring authenticity and believability of research findings.

Another personal challenge I faced in my research journey was convincing myself of the merit of using pseudonyms to represent the participants in my study, as opposed to using anonymity codes. As previously mentioned, coming from a science background where all research is largely experimental with little room for subjectivity, undertaking a qualitative exploration of this nature was still new to me, despite having conducted a qualitative study at master's degree level. The first iteration using pseudonyms therefore appeared to read, to me, like a kindergarten story rather than a piece of research. However, I did not like the idea of assigning numbers to my participants either; they are real people, all of whom gave up time over three years to help me answer my research questions. After much deliberation and reading other theses where participants had been assigned pseudonyms, I began to settle with the idea. On reading my findings in its current format, I feel that it was the right decision. As the researcher, there is a need to acknowledge the position of my research within broader disciplinary debates regarding the nature of theory and the method. As healthcare professionals, we are required to examine both our personal and professional values and beliefs and have largely been indoctrinated, or as Northway (2000) calls it, socialised into a research culture which promotes quantitative or scientific research. This perhaps accounts for my reluctance in writing in the first person and using pseudonyms. Especially important during this process was the guidance

and support of my supervisors. The critical discussions, rigour in questioning the study objectives and often debatable topics that flourished during supervision meetings have been most illuminating and rewarding. Their supervision approach has profoundly influenced the way in which I supervise my students. Their views over the years have helped shape my understanding of and position in social science research.

8.7 Summary

In this chapter, I have acknowledged my reflexive position as a researcher, in consideration of my additional roles as tutor, programme leader and senior colleague. I demonstrated awareness of the power dimensions and biases that may exist within my insider outsider positions and took measures to mitigate any of its effects. The process of qualitative research is very different to quantitative research in that we cannot be separate from our study. Instead, we are firmly immersed in all aspects of the research process and essential to it. The experiences of participants are real to us and we carry these participants with us as we work through their transcripts and analyse their responses.

Having provided a reflexive account of my research journey, the next chapter presents the conclusion of the study followed by recommendations drawn from the findings.

Chapter Nine

Conclusion and recommendations

9.1 Introduction

This section presents the key findings from my research study. The criteria for assuring trustworthiness in qualitative research are revisited followed by an appraisal of the relevant limitations and biases encountered during the study. Thereafter the original contribution to knowledge and practice is acknowledged followed by a number of recommendations for further work based on the findings. This section closes with a brief summary.

9.2 Findings in relation to the research questions

The aim of this study was to explore diagnostic radiography students' and tutors' respective understanding of the meaning of critical thinking and their perceptions of how this skill develops through the programme of study. The need for critical thinking skills development is couched as pragmatic and intellectual justifications which are written into learning, teaching and assessment material in higher education. Pedagogy does, therefore, have a significant role in the development of critical thinking skills, especially in the teaching of radiography, and presents a challenge to both tutors and students alike. The data revealed close similarities between the two main strands of exploration, which are the participants' understanding of the meaning of critical thinking and their perceptions of how critical thinking develops (see Sections 9.2.1 and 9.2.2.) and demonstrates that they are inextricably linked. From the findings, it is clear that learning has happened in both the university and clinical placement settings. The latter however was seen to have provided more opportunities for critical thinking skills development, with year two yielding the greatest growth. Student experience showed that their learning was not linear but was dynamic and shifting: from year one where there was a lack of clarity, to year two where there was greater clarity, and to year three where there was greater understanding. All students enjoyed participating in the interviews. It is pleasing to note that the experience encouraged them to think about their thinking.

9.2.1 The meaning of critical thinking

There is congruence in responses between the student and the tutor participants, which is an indication of a two-way validation of findings. Both groups were able to articulate their respective understanding of the meaning of critical thinking by using terminology that is found

in the published literature. It is evident from the responses, especially from the second and third phase student interviews, and tutor interviews, that the participants had some understanding of the meaning of critical thinking. This, therefore, contradicts my assumption, based on the literature, which professed that students and tutors do not understand the meaning of critical thinking. It is clear from their responses that critical thinking involves evaluating information using reason by weighing pros and cons, and decision-making by making thoughtful decisions based on evidence and reflection. Critical thinking also involves thinking about one's decisions taken in the past in order to make more informed decisions to bring about improvement in a similar clinical context. Drawing on the perspectives of student and tutor participants, a subject-specific definition framework of critical thinking is presented. Despite the vast amount of literature in the published domain, critical thinking suffers from a lack of conceptualisation for application in diagnostic radiography. Following the exploration of the meaning participants attributed to critical thinking, and based on the literature and my conceptual framework, a working definition of critical thinking, drawn from the definition framework (See Section, 6.2.1, p. 149) has been presented as follows.

> The critical thinking required of a diagnostic radiographer is to use ethically sound professional reasoning in making justifiable decisions in relation to examinations, diagnosis, and management of the patient within the field of medical imaging.

Having a specific definition of critical thinking applicable to diagnostic radiography brings about better understanding of its requirement in our daily practice as radiographers and ensures that decisions made are justified. Those decisions must positively impact on patient experience, care, safety and outcomes.

9.2.2 The development of critical thinking

Critical thinking skills development requires knowledge of the subject, cognitive and affective skills and the disposition towards using those skills. Although students were developing skills of critical analysis and evaluation at a basic level that enabled them to pass their learning outcomes, they were not developing 'good' critical thinking skills. As previously stated, the students' second year of the study yielded the greatest growth in terms of learning at both university and clinical placement, with year three enabling consolidation of previous learning leading to the development of new learning and knowledge encapsulation. Therefore, the greatest development was seen in relation to how students changed from being naïve when they were new to university to become more sophisticated thinkers, by the third year of study. These findings relate closely to those expressed by the tutors. Some students adequately demonstrated the possession of the dispositions required of a critical thinker, while critical

skills development remained a struggle for others. During the second and third phase interviews, students clearly articulated how their growing understanding of critical thinking helped develop their ability to apply their critical thinking skills. Some students did not recognise that their critical thinking abilities were more developed from the year before, yet they were able to clearly explain their critical thought process. What this demonstrates is that students' understanding of critical thinking developed as their knowledge of diagnostic radiography developed throughout their study period. They were able to apply their critical thought process in accordance with the level of knowledge acquisition and application expected at each level of study. Critical thinking development in diagnostic radiography is therefore dependent on the developing knowledge of diagnostic radiography as well as the skills and inclination to apply that knowledge in practice.

From the findings, a model characteristic of students' development of critical thinking in diagnostic radiography is presented (See Figure 7, p. 163). This model depicts the progressive nature of learning through a scaffolded approach from Level four to Level six as learning that moves along the continuum from working with simple/routine procedures to more complex/unfamiliar scenarios where modifications to set protocol are required. However, the learning trajectory was a non-linear one. When faced with a complex task, the students did not know what to do in the first instance and therefore became a novice again as they methodically thought through the situation, before taking action. Thus, it is plausible that students made the transition from being a novice student to expert student in simple situations, and then back to being a novice in more complex situations. Their development was affected by their experience and interaction with others demonstrating a constructivist approach to knowledge generation as they moved backwards and forwards in their learning in a recursive manner. However, each time they moved forward they went a bit further in their development. The model of critical thinking development characterises the learning at Levels four, five and six and is recommended as a helpful tool to guide the development of pedagogical material which will support the learning of student radiographers and training needs of academic tutors and radiographers in supporting the development of critical thinking skills.

9.2.3 The pedagogical implications for the programme

Despite the development demonstrated by the sample of student participants, the programme continues to experience challenges in relation to students' development of 'good' critical thinking skills. The findings revealed a number of concerns, discussed in Chapter Seven (See p. 167), which have implications for pedagogy on the diagnostic radiography programme. As critical thinking skills development is an expectation of HE, these concerns may apply to a

variety of disciplines and not specifically to diagnostic radiography. The implications for pedagogy, therefore, may be transferable to other programmes which have a clinical practice component. A number of recommendations for further work are given in the next section, which again can be usefully implemented in other similar programmes of radiography.

9.3 Recommendations for further work, actions and research based on pedagogical issues arising from the findings

The key recommendation stemming from the findings is the use of the model of critical thinking (See Figure 7, p. 163) which can be an effective tool in the following areas of pedagogical concern.

1. Scholarly activity or training is required to develop the ability of academic tutors and clinical mentors to write and explain feedback in a way that students are able to understand in relation to building their critical thinking ability and confidence. Congruent to this need is the staff development training that is required to support tutors in relation to increasing their own understanding of critical thinking to aid their explanation of this term to students. It is understood from the findings that students need to develop this skill, but equally important is tutor modeling of these skills. The model of critical thinking development indicates clear expectations of learning at each level. It is recommended for use as a practical guide to direct tutors' understanding so that they are able to effectively articulate and coach students in the development of higher order thinking skills as per the respective SEEC level. It will be of benefit to academic and clinical tutors on all diagnostic radiography programmes nationally.

2. There is a need to develop learning and teaching methods which involve a greater emphasis on clinical placement learning, for example, role play; case-study scenarios; problem-based learning tasks, and Socratic questioning methods. In addition, explicit links between the learning and teaching activities and critical thinking skills development are needed from Levels four to six. Furthermore, critical thinking skills instruction needs to include not just the cognitive higher order skills but also the affective dispositions as relevant to diagnostic radiography practice. The model of critical thinking development illustrates the staged learning that occurs with the scaffolded support from academic and clinical tutors. At Level four, student responses revealed vague and inchoate understanding, but as they entered clinical placement, they were supported by radiographers which resulted in greater and more confident learning. Their understanding of both cognitive thinking and affective dispositions grew in relation to patient contact

during their clinical placement experience. The students built upon their knowledge and understanding at Levels five and six. Their theoretical knowledge began to make sense in a clinical context, and they demonstrated the awareness of ethical and affective patient care considerations in their developing decision-making skills. The learning was recursive but lead to metacognition or thinking about thinking which is what, as tutors, we would expect to see at the end of their final year of study. These skills also contribute to the acquisition of graduate attributes which students are expected to develop during the course of their study. The model of critical thinking development maps a clear course of progressive development. Although it is iterative learning it is recommended as a chart of development for students, academic tutors and radiographers. The model is advocated as an exemplar from which to plan instructional pedagogy with a clinical focus and the specific aim of developing the critical thinking skills required at the various SEEC levels.

3. During the interviews, students demonstrated their developing understanding of critical thinking skills and how they applied this in their learning and practice. From my experience as a tutor, this learning does not always translate into an improvement in their academic grade. The students are developing different critical thinking expertise in the clinical setting compared with the academic setting. Although, the current marking criteria clearly set out the expectation for achievement of critical thinking ability at Levels four, five and six, the marking criteria relate to the academic components of assessment and may not be recognising the learning being picked up in the clinical setting. Further work is therefore required in the construction of a qualitative critical thinking test tool comprising structured questions to prompt reflective guided questioning of a student's thinking and decision-making and one that has the potential to enable deeper qualitative student feedback. This tool will be able to be used in both university and clinical placement learning and assessment, with the capability to impact more meaningfully on their learning. The model of critical thinking development can be used as a reference tool in designing appropriate assessment criteria that match the learning outcomes at each SEEC level. Furthermore, examples of writing at each level which clearly demonstrate how the levels of analysis develop from Level four to Level six will be of great benefit to the student and tutor as well.

Findings indicated that in addition, to bridging the theory-practice gap, there needs to be greater involvement of academic tutors in the clinical placement learning of students (See data extract from tutor participant, Mia, p. 132). Formalising regular clinical link tutor visits to students during clinical placement is therefore recommended. Although this was not a distinct aspect of my findings, it is in the data as evidenced above, and would be beneficial in supporting students.

There is contradiction in the higher education requirement of providing students with a good university experience while expecting them to develop as critical thinkers in the 21st century. Students stated through their candid responses that the spoon-feeding expectation from fellow students, and compliance from the tutors, is seen to limit their critical thinking ability. Further qualitative exploration is therefore needed in relation to students' expectation of a good university experience versus motivated, autonomous learning. In addition, greater elucidation of this dichotomous expectation is needed in order to clarify the learning needs of students, and expectations of staff, in relation to student engagement and fostering an independent learning culture, while meeting the institutional imperatives, like, for example, fulfilling NSS requirements.

Lastly, the findings demonstrated that although clinical placement had a profound role to play in the development of students' critical thinking abilities, significant challenges were revealed as evidenced in student responses. Students bring with them new ideas when they attend clinical placement. There must be shared learning between students and staff where they work together towards the common goal of delivering best practice in imaging services. Further qualitative exploration is needed in relation to how the traditional working of radiographers is impacting on students' training for autonomous practice. Radiographer leaders must support less experienced radiographers with the aim of improving their decision-making abilities. Furthermore, radiographers who are adept at using critical thinking need opportunities to step up and take on leadership roles within the profession and create change to result in more positive outcomes within the services they provide. These changes would hopefully positively impact on the learning and development of student radiographers' critical thinking abilities.

9.4 Limitations, sources of error and bias

I have already acknowledged and discussed a number of areas within Chapter Eight, which had the potential for bias. In terms of good research practice, nonetheless, I need to acknowledge the potential for bias in the research instruments used and how these were managed.

Firstly, face-to-face interviews were used as the research instrument, resulting in the potential for bias in terms of distortion in the wording of the interview questions, i.e. 'was I consistent in how I asked the questions in the interview?' For example, did I ask the questions in a leading manner? From observing the engagement of my participants during the interview, and on listening to the interview recordings on multiple occasions, I do not feel that bias was present in the manner in which I asked the interview questions. Furthermore, by being vigilant to the

potential for bias in this regard, I had engaged the participants in member checking of the transcripts, whereby they had agreed my transcription as an accurate record of the interview. This process confirms the transparency with which the process of interviewing was conducted. In addition, emergent themes from the interview phases were followed up during the next interview phase contributing to respondent verification of the early emergent themes and assuring trustworthiness of the interpretation of data.

Secondly, the scheduling of the third set of student interviews could be perceived to be a limitation due to the timing during which they were conducted. Had the interviews been conducted towards the end of the students' final year then there was potential for richer data to be collected regarding the development of critical thinking following the completion of their research projects and other assessment at Level six. However, due to scheduling constraints involving the programme year plan and student timetables, the interviews took place at the beginning of the students' final year of study. Furthermore, I had doubts about the students' willingness to return for another research interview as they neared the end of their study. Thus, I admit that I may have sacrificed potential additional richness of data for a suspected poor return of final interview responses.

9.5 Trustworthiness of the study

I have presented clear and accurate accounts of the processes that were followed during the conduct of this research study. I have critically analysed the criteria for the assurance of trustworthiness and can conclude that my research is sound research which was conducted methodically and rigorously. The findings are credible having followed a strict ethical and reflexive approach to sampling, recruitment, data collection, analysis, and interpretation. In terms of transferability of the findings of the study to other environments, as stated in Section 3.4, p. 58, I will leave it to readers to draw reasoned conjecture in relation to its applicability to other like settings.

9.6 Original contribution

It is an expectation that doctoral work makes an original contribution to the existing body of knowledge and practice. This study explored a unique area of diagnostic radiography education and training. The exploration of participants' understanding of the meaning of critical thinking, and their perceptions of the development of critical thinking, are both novel studies in diagnostic radiography. The latter involving the qualitative exploration of the development

of critical thinking is particularly unique in that it has not been previously investigated in any health profession discipline. A definition of critical thinking is offered together with a model of critical thinking development in diagnostic radiography, see Figure 6, p. 151, and Figure 7, p. 163 respectively. The findings from this study have the potential to instigate policy and curriculum design changes in radiography training. The research, therefore, makes an authentic contribution to diagnostic radiography education and practice.

9.7 Summary

In this section, the key messages from my study are summarised. Recommendations for further work, actions and research, based on my findings and current institutional experience, are suggested. The key recommendation is the use of the model of development of critical thinking in designing and implementing pedagogical tasks and training to support the scaffolded learning and development of student radiographers. The relevant limitations and biases are acknowledged. My position regarding the trustworthiness of my study is stated. In addition, I have established the authentic contribution this study makes to the existing body of knowledge and practice in diagnostic radiography and imaging. The fundamental message emerging from my findings is that one cannot live by cognition alone: the moment people are brought into a clinical scenario, complexity arises. Critical thinking skills therefore comprise of higher order thinking skills and affective dispositions. When making decisions for patients, one cannot simply think logically alone; one also has to think about the emotional, social and ethical domains in order to be clear about how the decision may affect the patient.

Developing the critical thinking skills of our students means that we will potentially produce graduates who will be able to think within and outside the protocol-driven basis of radiography and critically reflect on their practice in order to make self-correcting changes iteratively for effective practice. As responsible members of the radiography profession, our role as radiographers is to precisely argue our moral position, utilise our abilities with proper transparency and integrity, and exercise critical thinking and professional judgment in the service of differing individuals while making wise decisions. This movement will help shift the focus from radiography protocol driven examinations to critical thinking pathways, and benefit patients who remain at the heart of all considerations.

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APPENDIX 1: Evidence of no published thesis on this study topic

APPENDIX 2 The SEEC credit level descriptors

SEEC descriptors: by level

Level 4

Summary credit level descriptors	Develop a rigorous approach to the acquisition of a broad knowledge base; employ a range of specialised skills; evaluate information, using it to plan and develop investigative strategies and to determine solutions to a variety of unpredictable problems; and operate in a range of varied and specific contexts, taking responsibility for the nature and quality of outputs.
Setting	
Operational context	Operates in a range of varied but predictable contexts that require the use of a specified range of techniques and information sources.
Autonomy and responsibility for actions	Acts with limited autonomy, under direction or supervision, within defined guidelines. Takes responsibility for the nature and quality of outputs.
Knowledge and understanding	
Knowledge and understanding	Has a broad understanding of the knowledge base and its terminology or discourse. Appreciates that areas of this knowledge base are open to ongoing debate and reformulation.
Cognitive skills	
Conceptualisation and critical thinking	Identifies principles and concepts underlying theoretical frameworks and approaches, identifying their strengths and weaknesses.
Problem solving, research and enquiry	Identifies a well-defined focus for enquiry, plans and undertakes investigative strategies using a limited and defined range of methods, collects data from a variety of sources, and communicates results effectively in an appropriate format.
Synthesis and creativity	Collects information from a variety of authoritative sources to inform a choice of solutions to standard problems in familiar contexts.
Analysis and evaluation	Judges the reliability of data and information using pre-defined techniques and/or criteria.
Performance and practice	
Adaptation to context	Locates own role in relation to specified and externally defined parameters.
Performance	Undertakes performance tasks that may be complex and non-routine, engaging in self-reflection.
Team and organisational working	Works effectively with others and recognises the factors that affect team performance.
Ethical awareness and application	Demonstrates awareness of ethical issues and is able to discuss these in relation to personal beliefs and values.
Personal and enabling skills	

Personal evaluation and development	Is aware of own capabilities in key areas and engages in development activity through guided self-direction.
Interpersonal and communication skills	Uses interpersonal and communication skills to clarify tasks and identify and rectify issues in a range of contexts.

Level 5

Summary credit level descriptors	Generate ideas through the analysis of concepts at an abstract level with a command of specialised skills and the formulation of responses to well-defined and abstract problems; analyse and evaluate information; exercise significant judgement across a broad range of functions; and accept responsibility for determining and achieving personal or group outcomes.
Setting	
Operational context	Operates in situations of varying complexity and predictability requiring the application of a wide range of techniques and information sources.
Autonomy and responsibility for actions	Acts with limited supervision and direction within defined guidelines, accepting responsibility for achieving personal and/or group outcomes and/or outputs.
Knowledge and understanding	
Knowledge and understanding	Has detailed knowledge of well-established theories and concepts. Demonstrates an awareness of different ideas, contexts and frameworks and recognises those areas where the knowledge base is most/least secure.
Cognitive skills	
Conceptualisation and critical thinking	Identifies, analyses and communicates principles and concepts, recognising competing perspectives.
Problem solving, research and enquiry	Undertakes research to provide new information and/or explores new or existing data to identify patterns and relationships. Uses appropriate theoretical models to judge the significance of the data collected, recognising the limitations of the enquiry.
Synthesis and creativity	Collects and synthesises information to inform a choice of solutions to problems in unfamiliar contexts.
Analysis and evaluation	Analyses a range of information, comparing alternative methods and techniques. Selects appropriate techniques/criteria for evaluation and discriminates between the relative relevance and significance of data/evidence collected.
Performance and practice	
Adaptation to context	Identifies external expectations and adapts own performance accordingly.
Performance	Undertakes complex and non-routine performance tasks. Analyses performance of self and others and suggests improvements.

Team and organisational working	Interacts effectively within a team, giving and receiving information and ideas and modifying responses where appropriate.
	Recognises and ameliorates situations likely to lead to conflict.
Ethical awareness and application	Is aware of personal responsibility and professional codes of conduct.
Personal and enabling skills	
Personal evaluation and development	Assesses own capabilities using justifiable criteria set by self and others taking the wider needs of the context into account.
	Uses feedback to adapt own actions to reach a desired aim and reviews impact.
Interpersonal and communication skills	Adapts interpersonal and communication skills to a range of situations, audiences and degrees of complexity.

Level 6

Summary credit level descriptors	Critically review, consolidate and extend a systematic and coherent body of knowledge, utilising specialised skills across an area of study; critically evaluate concepts and evidence from a range of sources; transfer and apply diagnostic and creative skills and exercise significant judgement in a range of situations; and accept accountability for determining and achieving personal and/or group outcomes.
Setting	
Operational context	Operates in complex, unpredictable contexts, requiring selection and application from a range of often standard techniques and information sources.
Autonomy and responsibility for actions	Acts with minimal supervision or direction within agreed guidelines, taking responsibility for accessing support and accepting accountability for determining and achieving personal and/or group outcomes.
Knowledge and understanding	
Knowledge and understanding	Has a systematic understanding of the knowledge base and its interrelationship with other fields of study. Demonstrates current understanding of some specialist areas in depth.
Cognitive skills	
Conceptualisation and critical thinking	Works with ideas at a level of abstraction, arguing from competing perspectives.
	Identifies the possibility of new concepts within existing knowledge frameworks and approaches.
Problem solving, research and enquiry	Demonstrates confidence and flexibility in identifying and defining complex problems.
	Identifies, selects and uses investigative strategies and techniques to undertake a critical analysis, evaluating the outcomes.
Synthesis and creativity	Applies knowledge in unfamiliar contexts, synthesising ideas or information to generate novel solutions. Achieves a body of work or practice that is coherent and resolved.

Analysis and evaluation	Analyses new, novel and/or abstract data using an appropriate range of established subject-specific techniques. Judges the reliability, validity and significance of evidence to support conclusions and/or recommendations. Suggests reasons for contradictory data/results.
Performance and practice	
Adaptation to context	Locates own role within poorly defined and/or flexible contexts requiring a level of autonomy.
Performance	Seeks and applies new techniques and processes to own performance and identifies how these might be evaluated.
Team and organisational working	Works effectively within a team, supports or is proactive in leadership, negotiates in a professional context and manages conflict. Proactively seeks to resolve conflict.
Ethical awareness and application	Is aware of personal responsibility and professional codes of conduct and incorporates this into their practice.
Personal and enabling skills	
Personal evaluation and development	Takes responsibility for own learning and development using reflection and feedback to analyse own capabilities, appraises alternatives and plans and implements actions.
Interpersonal and communication skills	Sets criteria for, and is effective in, professional and interpersonal communication in a wide range of situations.

APPENDIX 3 Ethics approval notification

███████████████████████

███████████████████████████████

M E M O R A N D U M

TO   **Aarthi Ramlaul**

CC   **N/A**

FROM   ███████████████████████████████

DATE   **04 April 2013**

Protocol number: EDU/SF/UH/00007

Title of study: An exploration of the critical thinking in radiography education.

Your application for ethical approval has been accepted and approved by the ECDA for your school.

This approval is valid:

From: 04 April 2013

To: 31 December 2015

Please note:

Approval applies specifically to the research study/methodology and timings as detailed in your Form EC1. Should you amend any aspect of your research, or wish to apply for an extension to your study, you will need your supervisor's approval and must complete and submit form EC2. In cases where the amendments to the original study are deemed to be substantial, a new Form EC1 may need to be completed prior to the study being undertaken.

APPENDIX 4 Permission email from Dean of School

You replied on 08/02/2013 17:11.

Sent: 08 February 2013 16:56
To: Ramlaul, Aarthi

Dear Aarthi

Thank you for your email.

Permission granted.

Regards

■■■■■■

****

■■■■■■■■■
Dean of School
Health and Social Work
■■■■■■■■

Tel: ■■■■
Fax: ■■■
Mob: ■■■■■

Executive Assistant: ■■■■■■■
Email: ■■■■■■■

From: Ramlaul, Aarthi
Sent: 08 February 2013 16:54
To: ■■■■■■
Cc: Ramlaul, Aarthi
Subject: Permission to access students' and staff
Importance: High

Dear ■■■■

In order to fulfill the requirements for completion of my EdD study, I have to undertake a study involving human participants.

I am therefore writing to ask your permission to approach radiography students' and teaching staff in order to invite them to participate in my study entitled, "An exploration of critical thinking in radiography education".

Once your permission is granted, I will proceed to apply for ethics approval, and will forward to you the study protocol number thereafter.

I have attached my study proposal herewith for your information and interest.

Look forward to hearing from you.

Kind regards
Aarthi
EdD Year 1

APPENDIX 5: Student participant information sheet

Title of Research: An exploration of critical thinking in radiography education

Introduction
You are being invited to take part in a research study. Before you decide whether to do so, it is important that you understand that research that is being done and what your involvement will include. Please take the time to read the following information carefully and discuss it with others if you wish. Do not hesitate to ask us anything that is not clear or for any further information you would like to help you make your decision. Please do take your time to decide whether or not you wish to take part. Thank you for reading this.

What is the purpose of the study?
The purpose of the study is to explore what is understood by the term critical thinking and how you perceive this skill to develop through a programme of study.

Do I have to take part?
It is completely up to you whether or not you decide to take part in this study. If you do decide to take part you will be given this information sheet to keep and sign a consent form. Agreeing to join the study does not mean that you have to complete it. You are free to withdraw at any stage without giving a reason. A decision to withdraw at any time, or a decision not to take part at all, will not affect the support you receive on the programme.

What will happen to me if I take part?
If you decide to take part in this study, you will be required to attend a one hour face to face interview in year one, year two and year three as you progress on the programme.
The first thing to happen is that I will schedule a mutually suitable date and time to meet.

What are the possible disadvantages, risks or side effects of taking part?
There are no perceived risks or side effects of the study. However you will be asked to give an hour to attend the interview.

What are the possible benefits of taking part?
You will benefit from discussing feedback on assessment and possible reasons of why students do not generally perform well in the upper grade bands. This will enable the researcher to gain an insight into critical thinking skills development in radiography education, and address the feedback points emerging from the interview. If results of the study indicate that there is a need to implement good practice measures with regards to critical thinking skills development in radiography education, the researcher would instigate this through curriculum redesign, which will be of benefit to all radiography students, current and future.

How will my taking part in this study be kept confidential?
Your involvement in the study will only be known to the researcher. All consent forms, recordings of interviews and interview transcripts will be kept securely. Only I

will have access to this. Electronic data will be kept on a password protected laptop to which only I will have access to. Participants will be allocated a unique anonymity number during the interview process and all transcripts will bear this number. The data that will be used in the study will not identify any participant individually therefore confidentiality and anonymity will be maintained.

What will happen to the results of the research study?
The results of the study will be written up and submitted as a doctoral thesis as part fulfillment of the Doctor of Education degree. The results will be kept securely for a period of 3 years as per University regulations. I will be the custodian of the data.

Who has reviewed this study?
The study has been reviewed by the ███████████████████████████████ Ethics Committee - Ethics approved by ██████████ on 18th February 2013

Who can I contact if I have any questions?
If you would like further information or would like to discuss any details personally, please get in touch with me, by phone or by email. You are also free to contact any of my research supervisors. All contact details are given below.

Researcher:	Mrs Aarthi Ramlaul
Office no.:	(01707) 286459
Email:	a.ramlaul@herts.ac.uk

Supervisors: ████████████████████████████
████████████████████████████████

Although we hope it is not the case, if you have any complaints or concerns about any aspect of the way you have been approached or treated during the course of this study, please write to the University Secretary and Registrar.

Thank you very much for reading this information and giving consideration to taking part in this study.

APPENDIX 6: Tutor participant information sheet

Title of Research: An exploration of critical thinking in radiography education

Introduction
You are being invited to take part in a research study. Before you decide whether to do so, it is important that you understand that research that is being done and what your involvement will include. Please take the time to read the following information carefully and discuss it with others if you wish. Do not hesitate to ask us anything that is not clear or for any further information you would like to help you make your decision. Please do take your time to decide whether or not you wish to take part. Thank you for reading this.

What is the purpose of the study?
The purpose of the study is to explore what is understood by the term critical thinking and how you perceive this skill to develop through a programme of study.

Do I have to take part?
It is completely up to you whether or not you decide to take part in this study. If you do decide to take part you will be given this information sheet to keep and sign a consent form. Agreeing to join the study does not mean that you have to complete it. You are free to withdraw at any stage without giving a reason. A decision to withdraw at any time, or a decision not to take part at all, will not affect you in any way.

What will happen to me if I take part?
If you decide to take part in this study, you will be required to attend a one hour face to face interview, which will be scheduled at a mutually suitable date and time.

What are the possible disadvantages, risks or side effects of taking part?
There are no perceived risks or side effects of the study. However you will be asked to give an hour to attend the interview.

What are the possible benefits of taking part?
You will benefit from discussing feedback on assessment and possible reasons of why students do not generally perform well in the upper grade bands. This will enable the researcher to gain an insight into critical thinking skills development in radiography education, and address the feedback points emerging from the interview. If results of the study indicate that there is a need to implement good practice measures with regards to critical thinking skills development in radiography education, the researcher would instigate this through curriculum redesign, which will be of benefit to all radiography students, current and future.

How will my taking part in this study be kept confidential?
Your involvement in the study will only be known to the researcher. All consent forms, recordings of interviews and interview transcripts will be kept securely. Only I will have access to this. Electronic data will be kept on a password protected laptop to which only I will have access to. Participants will be allocated a unique anonymity number during the interview process and all transcripts will bear this number. The

data that will be used in the study will not identify any participant individually therefore confidentiality and anonymity will be maintained.

What will happen to the results of the research study?
The results of the study will be written up and submitted as a doctoral thesis as part fulfillment of the Doctor of Education degree. The results will be kept securely for a period of 3 years as per University regulations. I will be the custodian of the data.

Who has reviewed this study?
The study has been reviewed by the ███████████████████████████████ Ethics Committee - Ethics approved by ████████████ on 18th February 2013

Who can I contact if I have any questions?
If you would like further information or would like to discuss any details personally, please get in touch with me, by phone or by email. You are also free to contact any of my research supervisors. All contact details are given below.

Researcher: Mrs Aarthi Ramlaul
Office no.: (01707) 286459
Email: a.ramlaul@herts.ac.uk

Supervisors: ████████████████████████████████
██

Although we hope it is not the case, if you have any complaints or concerns about any aspect of the way you have been approached or treated during the course of this study, please write to the University Secretary and Registrar.

Thank you very much for reading this information and giving consideration to taking part in this study.

APPENDIX 7: Consent form

████████████████████

CONSENT FORM FOR STUDIES INVOLVING HUMAN PARTICIPANTS

Title of Research Project: An exploration of critical thinking in radiography education

	Yes	No
The purpose of the study has been explained to me.	☐	☐
I have been informed of the details of my involvement in the study.	☐	☐
My questions regarding the study have been answered to my satisfaction.	☐	☐
I understand that I am not obliged to take part in this study and may withdraw at any time without the need to justify my decision and without affecting me in any way.	☐	☐
I understand that any personal information obtained as a result of my participation in this study will be treated as confidential, and will not be made publicly available.	☐	☐
I understand that the interviews will be voice recorded	☐	☐

I, the undersigned, agree to take part in this study

Signature of participant…………………………………………………..

Name of Participant….……………………………………………………

Signature of Investigator…………………………………………………………….

Name of Investigator……………………………………………………

Date…………………………………..

Ethics protocol number - EDU/SF/UH/00007

APPENDIX 8: The pilot interview schedule for student participants

Introduce myself and acknowledge the fact that they may not have been part of a research study before.

Using prompts - get them started on talking about how they think about things from everyday life.
How do they think their opinions are formed? What makes them think or believe that they had good thoughts.
Have you had to make a decision/ choice before? About anything? Would you like to share that story with me?
What decision/ choice did you have to make?
How did you make it?
What things did you think about?
Were you happy with the decision you made?
How do you know that you made the right /correct decision?

May lead to objectivity in their judgments...in how they evaluated the arguments.

May lead to reasoning - can prompt further to explore how the reasoning took place? Was the reasons used considered to be reliable?
In what way/ how do you know?

Have you heard the term 'critical thinking?'

Can you tell me what it means?

Can talk about thinking being purposeful or goal-oriented. Can prompt by asking what the focus of the decision/ or choice was and what was the desired outcome? What were you expecting to get out of the decision or choice?
Was action taken as a result?
What action was taken? What was the effect?

Can explore the ethics of the thinking involved by asking how did it make you feel? Were you happy with the outcome? Why?
Did it influence your beliefs in anyway?

Reflection - have you learned anything from the process of making the decision or choice? What did you learn? How did it influence or affect you in terms of what you will do differently if you had to make a decision again?

Attitudes and dispositions- To be able to think carefully, do you feel that requires you to have a specific attitude as such?

What would the attitude of someone like that (thinker) be like?

How you do think critical thinking skills can develop?

Is there anything else you wish to add?

Thank them for their time

APPENDIX 9: The first phase student interview schedule

Acknowledge the fact that they may not have been part of a research study before, so invite them to have a chat with me rather than be interviewed.

Begin by giving a clear contextual narrative of the study area and interview to set the scene

Start off by asking the participant to - tell me about what has led them to study radiography...(can use their reason as an example of their decision making process).

Let's talk about how you see things in everyday life. Do you usually accept information as it comes to you?

What do you do when you have to think about something? *Let them start talking about how they think their opinions are formed?* How are those thoughts formed?

Have you had to make a decision or a choice before? About anything?

Would you like to share that with me? How did make that decision/choice? What things did you think about? Were you happy with the decision or choice made? Do you feel it was the right/correct decision? How do you know that it was the right /correct decision?

May lead to reasoning - can prompt further to explore how the reasoning took place? Were the reasons you considered thought to be reliable? In what way / how do you know? Think about your work experience or how radiographers make decisions, how you carry out a piece of research? How do you decide whether to use the information you have got or not?

May lead to objectivity and judgment – how did you decide to use or evaluate the information you were thinking about?

Can then explore their thinking process as a goal where they expected to reach a decision which was an outcome or a purpose. Can prompt by asking what the focus of the decision/choice was and what was the desired outcome? What were you expecting to get out of the decision or choice?

Was action was taken as a result? What action was taken? What was the effect?

May lead to the ethics of the thinking involved – can prompt to explore the ethics of the thinking process by asking 'how did it make you feel?' Were you happy with the outcome? Why? Did it influence your beliefs in any way? How?

Do you feel that everybody can think? Or are certain people able to think 'better' than others? Why do you feel so? Are there any examples from your experience?

Do you feel that requires you to have a specific attitude as such; or an inclination towards a certain way of thinking?

What would the attitude/ character/ nature of someone like that be like?

Looking at the big picture of working as a radiographer - do you think that having such an attitude/ character or nature is important in radiography/ or to you becoming a radiographer?

Do you feel that you learned anything from the process of thinking carefully/making a decision/choice? What did you learn? How did it influence or affect you in terms of what you will do differently in future? This is your reflection of the learning process...

So what do you think critical thinking means?

Do you feel you are beginning to develop this skill? How?

Why do you think it is important to develop this skill as a radiographer?

Is there anything else you would like to add?

Thank them for their time

APPENDIX 10: An example of a student participant interview transcript

AR. Let's start off by talking about what made you decide to study radiography…

I. I was at this time in my life when I was thinking about doing something meaningful with my career. And having already got a degree in XXXXX, I hadn't got far with it actually in terms of career prospects and then I heard about radiography, and then I went and did some clinical work experience and thought it was fantastic. So, I thought I'd apply and enter the profession as it's got great career prospects and had the opportunity of actually making a difference instead of struggling to actually find employment or research funding with the degree given the recession (and, for example, the freeze in civil service recruitment).

AR. When you attended your work experience day, what specifically did you like about what you saw?

I. I think it was probably the patient interaction actually. It was quite a small hospital so maybe I got a slightly silver lining impression, as it was a hospital in a little village. But I thought it was lovely. All the patients...like I worked in customer service before and I thought that working with the general public can be horrendous, but I was actually really surprised in healthcare and working in X-ray. All the patients were really nice, all were nervous and vulnerable, and the radiographer always managed to make them smile. And even if they had something pretty bad wrong with them, they went away, and you could tell they were really satisfied with their experience and I think that would be nice to reproduce really.

AR. Let's talk about how you see things in everyday life. When you getting information on a daily basis, what do you do with information, how do you see it? Do you take it in? Do you believe it?

I. You mean how do I learn?

AR. Well…yes okay

I. I am a really bad auditory learner. I'm actually not very good. Lecturing isn't good for me to take in stuff however I have a strong visual reading ability, so I can basically read, and rote learn very easily just by reading.
But I'm not really the kind of person that learns by listening and not really so much by doing. I mean more so than listening but less so than reading. I don't have a photographic memory, but I can just take in more through reading textbooks and journals and stuff like that.

AR. What about general information? What people tell you.... information from friends?

I. If I don't understand what's being said I will always ask questions. You'd probably seen in lectures that I often put my hand up quite a lot and I sort of always have to clarify in my mind what's going on.
I think it's because I'm not good at picking up information the first time round so I have to sort of say, 'oh okay, this leads onto that...'
I have to sort of clarify it but obviously if I'm reading something it's already written, pretty much perfectly so I get it straight away.

AR. Interestingly you said that if you didn't get something the first-time round, you would then ask questions, and you will then build up your opinion about that something…

I. Yeah but it depends on whether it is an opinion or whether it is a factual comment.

AR… Say a bit more about that

I. Okay, if it's factual evidence then I will just do my best to glean what the facts are and how they were learned. If it's an opinion, well again it's a vague subject area then I would probably propose different moral dilemmas to them and see if it measures up logically in my mind.
I am a logical thinker and I don't like illogical thinking, and I have to always challenge it and put forward a different viewpoint, because I want to understand why that person has a different opinion to me.

AR. So straight away then you actually don't believe what you hear at face value?
I. Well instinctively, I'm quite cynical, I like to challenge everything to make sure it is right actually. I'm a bit of a perfectionist so I like to know what the 'right' answer is.

AR. You say you like to challenge things to make sure it is 'right', what do you mean by 'right'?

I. Factually correct, especially in science and in radiography we deal with facts, so it's important to know the right answers.

AR. Equally in radiography we deal with the patient?

I. Yes but there are right answers where that's involved as well. We just haven't figured that out yet at this stage.

AR… So how can something that is factually right in science be equally right on the patient care side of radiography?

I. Well I guess this is a psychological issue but it's still science. If you look at a person from the base of their actions, their needs and their wants, everything boils down to genetic and environmental factors. So, if we reach a stage where we can understand somebody's biological make up, and also understand factors that influence their development in the environment, then we can understand how to treat those people in context better. Obviously at the moment we are miles off from having that kind of critical analysis, so we have to use methods, not trial and error, we have to use methods which seem the most beneficial without the presence of pure science.

AR. Give me an example where something like this would be used.

I. I guess it would just boil down to logic depending on what information is available. For example, I would use empathy, logically I don't like being treated this way, so I use empathy to place myself in the patient's shoes. In class we are taught the importance of empathy but it's entirely different from person to person. Because each of us are different, it is quite difficult to put yourself in someone else's shoes as it's different from person to person.

AR. Why is it importance to be able to have this awareness as a radiographer?

I. It is for better practice on a societal level, and it's better for the perceptions of the general public and general society that we are doing a good job as radiographers…

APPENDIX 11 An example of a tutor participant interview transcript

AR. Thank you very much for giving me your time today.
Do you feel that there are different forms of thinking?

I.Yes. Well it is not an area that I know massively about which is why I was interested in doing this. We learned a lot about in the Continued Professional Academic Development (CPAD) course and as I was going through my notes I came across a lot of notes about critical thinking.

AR. How would you define critical thinking?

I. Thinking is such a broad area. In its simplest form, it would be just using your brain to gather information and make a decision about that. Even if that was just a mathematical calculation like adding up A and B and arriving at C. It would be about working things out in your head. But then you are thinking all the time. Sometimes it's just about observing something and becoming aware of it. So, it's like thinking that is a pretty view over there. That does not make it a critical comment because it is my opinion and I am not basing it on whether the sky is blue, or the trees are green etc. it's just an appreciation. It's reacting to our senses and having an opinion or having a feeling about that.
So, I think part of it is just being on one end of the scale and just feeling or reacting to some stimulus or whatever, which can also just be boredom. This will be different to critical thinking where you have to take in several parts of information and data to make a decision about what you want to do, whether it is deciding what to cook for dinner.

AR. How does feeling bored affect how you feel about what you are doing at that moment?

I. That's a really hard question. I think your emotions will change how you feel about certain things. I am often told that I am a really positive person. And so, I will rather think how we can make this better even though I am probably feeling, 'this is an awful situation.' My brain will always be going on to think about how we can make this better. I am naturally inclined to look for a way out. A win-win for everyone.
I know that this is a good thing and a bad thing especially in terms of advising students. It should not be me finding information for them. It should be me really helping the students make the decision for themselves and that is a difficult skill to develop I think. I am still trying to develop this skill.
The feeling that you are bored may affect the way you make decisions.

AR. Have you heard the term critical thinking then?

I.Yes I have

AR. What do you think critical thinking means?

I. In terms of academic writing and considering what is required for that, it is not only about making decisions but is also about taking information from places, weighing up their value and making your decision. The fact that you really have to weigh up the value is what makes it really critical. So, if you are looking at evidence it is about how much you believe the evidence and then making a decision about whether that can be applied to your situation, like making clinical decisions.
If you get a request for a CxR, and the information on the form may not fit in with what you know to be the protocol. It's about trying to decide whether this information fits and should be used or should an alternative be used. So, it's about gathering the evidence, deciding how

worthy it is and using that to make your decision. It's quite complicated as you have to consider several things and within the context you are dealing with.

AR. You used a very powerful word, you said worthy. What would it be about the information that we could receive that would make it worthy?

I.It would be about things that are in the same context because you cannot compare apples and oranges. So, it's about where the information has come from, how reliable is it as a source, how has that information been derived. For instance, with the X-ray form, has the doctor looked at the patient or was it completed by somebody else, how relevant the information is and how recent it is? And it's kind of… you have set criteria for everything that you do. You will consider the criteria but weigh it up against your own set of values in terms of numeric values.

AR. Very interesting. How will you do that?

I.If I was thinking about something like comparative imaging, we get the students to look at the patients' referral pathways where we want them to learn more and understand the protocol, to understand why things are that way so that they can make an informed decision about them. So, it's about, if you have several modalities that can all answer the clinical question, you then need to look at them under specific criteria. To think up various things, e.g. sensitivity, specificity, cost, waiting times, accessibility or whether it is going to make a difference to the patient pathway. Could other imaging be used and get the same results, etc? This will get them to think about the 'roundedness' of their approach to thinking and the effect on the decision made.

AR. How do your values come into this scenario?

I. Understanding and knowing that you want to have high sensitivity and specificity values, but that there are also your personal values, e.g. patient perceptions of a difficult situation about their procedure etc. You have to consider whether it all adds up and once you are happy that you have analysed everything correctly, a right decision can be made.
You have to take into account the information at hand, on the job especially in cases where, for example, the patient cannot be positioned in a particular way, you will have to adapt your technique, and use your clinical reasoning abilities to ensure that you get a good quality image but keeping the patient comfortable and safe.
So even though you have to consider all the physical things, you also have to be in touch with the emotions that come up. Sometimes you may encounter a patient who would be very difficult to do something or uncover part of their bodies. You have to think about the whole person and not just what they physically can do.

AR. In the literature critical thinking has been linked to purposeful, reasoned, reflective and ethical thinking. How would this impact on what you have said?

I. You have to think about this. you have to think about how we will be able to do, can the patient do this, are there other things that I need to consider? For both males and females. If it's a male, I will need to ask the patient what they can do or if they are happy to move and if they are not, you will have to change your plans.
With regards to the ethical thinking - I think I see this with patients with headdress. I feel that we should always respect other's values and accommodate wherever possible. It's only really during out-of-hours that their specific requests may not be able to be made…

APPENDIX 12: The second phase student interview schedule

Begin with a welcome and thank participants for attending the interview
Give participants a clear contextual narrative of the study area and the second interview to set the scene.
Explore the interview objectives with them and probe to get responses with regards to what influenced them as appropriate

Keep as simple as possible and use the participant as the lead

1. Explore whether their understanding of the nature of critical thinking had changed from their view/s last year.

   If so what influenced the change?
Probes   - was it clinical placement or a learning activity?
   -refer to the participant's previous transcript and pick out any relevant themes or points needing further exploration, e.g. some students have mentioned X, what do you think about X?

2. Explore whether they perceive their critical thinking skills to have developed from last year?

   Why do they think so?
Probes   - was there a specific incident or event that contributed in any specific way?
   -did clinical placement influence them in any way?
   -did the teaching activities at university influence them in any way?
   -did the people you interacted with, e.g. personal tutors, clinical link tutors, clinical mentors influence them in any way?
   - were there any critical incidents in which they suddenly had a 'light bulb' or 'Eureka' moment when they felt the 'penny drop'?

3. Explore the following themes from the first phase interviews:
   -consequences of taking quick decisions
   -the negative effect of decisions on patient outcomes
   -the link between 'good thinking' and self-confidence
   -deep thinking versus superficial thinking

Scenario *(use as a reference only and probe when appropriate)*
Think of a real scenario that occurred recently – can be a personal incident from home, university or clinical placement block.

A1. Explain your point of view
2. Explain the other person's point of view
3. Explore whether they are able to see the differences between points of view.

B1. Describe how you felt about what happened
2. What thoughts did you have? How did the thoughts relate to the fact of what happened?
3. Explore whether they are able to see the difference between their opinion and the facts.
4. Explore whether they are able to identify reasons or opinions about what happened or if there were pros and cons to the argument.

C1. Are you able to identify your assumptions about the event and describe your point of view?
2. Explore their evaluation of the credibility of sources of information
3. Explore their ability to evaluate rationales to support conclusions

D1. Are you able to make a judgement of the information and/or the event?
2. How are you able to give an appraisal of the information and/or the event?
3. Are there certain skills or tools that you have used to do this?

***E1. What might the purpose of reflecting on this issue be?* What might the problem or issue be?**
2. Where did your assumptions come from? Were they valid?
3. What information was available to help you understand this event? What other information might you need?

F1. Explain your reasoning process that you followed in reaching your conclusion.
2. What theory or information did you find useful when analysing your thinking in this scenario?

G1. What are the consequences of your thinking in relation to the event?
2. What conclusions can you draw?
3. What are the implications for your professional practice?

Is there anything else you would like to add?

Thank them for their time once again

APPENDIX 13: The third phase student interview schedule

Begin with a welcome and thank participants for attending the interview
Give participants a clear contextual narrative of the study area and the third interview to set the scene.
Explain the overall objective to get an update on their journey and enable them to reflect on what their thinking is now.

1. Explore whether their understanding of the meaning of critical thinking had changed from their view/s last year…
   a. What influenced their understanding and views?

2. Explore whether they perceive their critical thinking skills to have developed from last year? If so, in what way…get examples…
   Explore some of the key responses from their 2nd interview
   a. Role of clinical placement
   b. Linking theory to practice
   c. Change in your attitude or perception
   d. How did you manage your thinking in performing simple tasks vs complex tasks?
   e. How did feedback encourage and motivate you?

3. Explore some of the themes emerging from previous interviews…
   a. Is all thinking critical thinking? How would this apply to new situations?
   b. Can reflection be critical thinking?

4. Get their opinion on a fit for purpose definition of critical thinking – explore what key words they would choose to use to define critical thinking.

5. Explore what learning and teaching options (pedagogy) they found helpful in developing critical thinking skills.
   a. If they perceive critical thinking skills not to have developed – explore implications for pedagogy for the programme

6. Explore their experience as a research participant and a student on the programme. Has being part of this study influenced them in any way?

Thank them for their time over the 3 years and wish them well.

APPENDIX 14: The tutor interview schedule

Begin by giving a clear contextual narrative of the study area and interview to set the scene. Thank them for agreeing to take part in the interview.

Let's talk about thinking – do you feel that there are different forms of thinking – can prompt with ...ordinary, creative, insightful...

Have you heard the term 'critical thinking?'

What do you think 'critical thinking' means?

Prompt to explore how critical thinking relates to purposeful, reasoned, reflective and ethical thinking. Is there a difference? What is it? What do they mean to each other?

Why do you think it is important in radiography? *(Explore role of clinical practice, theory to practice learning, role of reflection and feedback)*

The university as part of their Graduate Attributes expects students to have achieved the development of critical thinking skills by the time they graduate - do you know how critical thinking might develop during study on the radiography programme?

Do you think that critical thinking can produce an improvement in education? How would the improvement be noticed? How would it be different from what we are seeing currently as tutors in terms of student performance?

Do you think we offer teaching and learning activities that enable students to develop this skill?

Is there anything else you would like to add?

Thank them for their time

APPENDIX 15: Sample transcript pages showing highlights and codes

instance showed that many people on our course do want their hands holding all the way through the course, without having to do too much thinking of their own.

How do you perceive the development of critical thinking through the programme at university?

Great question. Whilst there are some students who will already have well-developed skills in this area, there are others that won't. This should, though, be a learning experience for everyone as there is always room for development. Each assignment we complete is returned with feedback. Part of the marking grid relates to the thought that has gone into it, how arguments have been advanced, and so on. If anyone scores less than perfection in this area, they should be taking every opportunity to develop their skills, taking on board the feedback that they have been given. I'm sure that there are many people who are less than happy with their mark on the recent PPP assignment, possibly falling down on the "critical thinking" aspect - so they should look at their feedback and see how they can improve next time. In many ways, this is one of the key points from university – this isn't about simply regurgitating knowledge, but showing that you understand and can appraise information. If you follow this practice, your marks should improve over time, but for some people it would need to be a conscious effort whereas I feel that it comes more naturally for others.

Handwritten margin notes:
- Various ages and abilities in a large class
- different maths abilities
- why do not use their FB on assignments to improve.
- If they did this their works will improve, in terms of critical analysis

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this is when critical thinking comes into play to say, do I agree with this, with the methods used, the people they spoke to, how they got to their results, etc...and actually look at it more deeply. I will also look for information that presents a different viewpoint, especially in academia, where you need to look at what other views are there out there. Is there a consensus on the matter? You ask yourself, 'well what is my view?', 'who do I agree with here?' Sometimes you get to a conclusion and sometimes you don't. There may not necessarily be an agreement but it is important to go through the process to get that point where you say, actually this is what I have from that, and it either leads somewhere or more information is needed to conclude that.

(Was running out of time at this stage, and AR asked if she can email the questions not covered...Part M agreed).

Can everyone think or are there different thinkers among us? How do we know this?

I think that it's certainly the case that everyone CAN think, it's more whether they DO think. Everyone has the ability for conscious thought, regardless of the level of intelligence (for example) but as I suggested before, some people seem to be "happy with their lot", they accept things at face value and don't challenge. Which is fine, that's not a criticism, society wouldn't be able to function without these people. There are definitely "different" thinkers amongst us - if there weren't, society would never progress. If it wasn't for the way in which Tim Berners-Lee thinks, there would be no internet; if it weren't for Bob Geldof thinking "outside the box", the charity movements over the last 29 years would have looked very different. These are people who were either capable of original thought or were capable of challenging the status quo. And those are just two examples off the top of my head.

Handwritten margin notes:
- Self-questioning + reflecting
- everyone can think
- some choose not to think.

APPENDIX 16: Units of information

<u>On decision making</u>

Lack of self-confidence

Relies on past experience

Opinions formed from experience

Weigh the pros and cons / good and bad/ positive and negative

Evaluate the information

Obvious decisions are quick

Complex decisions take time

Make a balanced evaluation

Making a right decision

Being happy with the decision made

Sense of achievement of making a right decision

Consequences of making a quick decision

See the full/bigger picture before making a decision

Reflect on what went wrong and why and how you can rectify the situation/ decision

Make accurate decisions

Consensus on a decision

Doubt a decision

Seek other people's advice for reassurance

Self-doubt

Confidence in making the right decision

Negative impact on making the wrong decision

Decision making is hard

People pleaser

Indecisive

Justify information

Leading to an action

Prioritise

Making the right decision morally

Negative effect of patient outcomes

Intrinsic feeling of 'calm' / content or satisfaction of making a good decision

Reasoning guides decisions which lead to actions

Reaching a goal

Using experience to guide a decision

Using your own discretion and judgment

Situational influence in a busy hospital

Quick decisions take less time

Complex decisions take more time

Justify reasons

Cannot make a decision without knowledge

Uses evidence

Deliberate over decisions and over thinking

Autonomy in decision making

On thinking

Look up new information

Not accept information at face value

Questions practice or things they don't agree with

Ethics, beliefs and values affect thinking

Can do things without thinking

Different ways/ types of thinking/ thought processes

Better thinkers may be arrogant - need to always be correct

Must be open to listen to others' views

You have to think things through

Not good at fighting their own case.

Accepting information at face value/ not wanting to challenge

Lack of confidence

Wants to please people so would not question people

Trust in their own thinking

Instinctive thinking

Consequences of an action

Good thinkers are confident thinkers

Careful thinking

Emotional thinking

Over think things

Objective thinking vs emotional thinking

Less emotion to be objective

Intuitive /instinctive thinking

Superficial vs deep thinking

Rational thinking

Valid argument

Deconstructing complex statements

Think things through

Using reliable information/ reasons

Making assumptions

Rethink your thinking

Balanced thinker

Situational thinking

Scientific way of thinking

Balanced thinker

Link between good thinking and self-confidence

Confusion and uncertainty in doubt

Trust reliable sources

Opinions are formed at a young age

Not question authority

Seek consensus or advice from people for reassurance

Feeling of what is right

Some people don't think or use their common sense

Influence of the environment

Make sense of information

Influence of upbringing on thinking

Effect of environment on thinking

Thinking process leads to a goal or an outcome

Thinking is vital for everything in life

Lazy people choose not to think

One's thinking can sometimes be wrong

Different learning styles affect how one thinks

Perfectionist thinking - they are always correct

Thinking can be an impediment sometimes

Grounded views

Consider others' views

Not wanting to think

Being 'spoon fed' information

Understanding of the meaning of critical thinking

Critical thinking needs experience

Tutors teach critically

Students do not understand what critical thinking means

Informed judgmental thinking

'all thinking is critical thinking'

Not straightforward thinking

Looking at both sides of things before taking a decision

Weighing up two sides of an argument and then using reason to lead to the best conclusion

Weighing out the points of information, analysing and finding out what's important and what is not. Then making a decision.

It is partially about decision making - reflecting on decisions made and deciding if they are right or wrong.

Take a situation, and look at the good and the bad, and then reflect on the decision you made.

Critical thinking requires knowledge, a process of reflection, the weighing up of all the different ideas to make the right decision. The decision makes you happy and leads to a good outcome for the patient.

Thinking around the subject in great depth rather than just simply applying basic knowledge to a certain situation.

Critical thinking is about exploring one thought or decision carefully rather than just thinking and acting straight away.

It is deep thinking rather than superficial thinking.

It involves decision making and exploring all the options available.

Thinking that leads to a determined outcome where there is a goal.

To analyse information in order to see the good side and bad side, put them together to help you understand it

To reflect on what you have analysed and form your own opinion on it.

Critical thinking needs high processing power.

Adaptable thinking

Means questioning yourself about the various views that present themselves, asking yourself 'whether there is a consensus view, what is your view and who do I agree with, or not agree with, and finally what is the outcome'.

Self-questioning and self-reflecting.

Critical thinking development

Through practice in academic work by writing, reviewing, making changes based on feedback and repeating the process.

Based on how you would go about using information to improve what you are doing, e.g. in receiving essay feedback, you will use that feedback to improve so the same mistake will not be made twice.

Develop your writing or ideas further following feedback.

Learning by observing other people.

More opportunities to think independently like problem-based scenarios.

Getting better at making decisions

Reflection and learning from mistakes

Thinking becomes clearer in the decision-making process

Certain situations are not straight forward

Cannot develop critical thinking by writing exams

Coursework and writing essays help critical thinking development

Double check understanding

Fast learners

More reading, more practice at writing and using your thinking in picking out the main points

By making better decisions and knowing that you are able to think things through quicker.

Through reflecting on their personal experiences and learning from experience and making improvements to their experience.

Learn from mistakes

Learning by doing

Reflection of who you are in how you do things. Your personality is reflected in your work.

Discuss your decisions with other people to help your reflection.

Strong links with learning at clinical placement, especially seen in the theory to practice learning at placement.

Students expect to learn a lot more at placement

By developing a greater depth of thinking compared to when they were in A level study. This will improve reasoning and enable you to handle more information at one time.

Understanding grows

Need knowledge to be able to think critically

University encourages us to think differently so I feel I am beginning to develop critical thinking.

Critical thinking is seen as a life skill. I use it on a day to day basis in whatever I do, so yes, I have developed this skill.

People either have critical thinking abilities or they don't.

It is difficult to improve someone else critical thinking abilities, especially if it is someone who has no mechanism to structure their thinking.

For extremely intelligent persons, it may be difficult for them to coherently organise their conflicting thoughts for someone else to read.

Promoting logical thinking will promote critical thinking to an extent that students will allow.

A large class has different people with different thinking abilities. Some have developed critical thinking skills and others have not

If students used their feedback to develop their writing and improve, then their critical analysis would improve, and they would not get the same comments over time.

Thinking patterns became more habitual

Feedback from university tutors

Enhanced linking in theory to practice

Role modelling by some radiographers

Mentors influenced thinking

Increase in self-confidence and assertiveness

Positive encouragement from mentors

Learn to trust their own judgment

Make decisions faster

Positive feedback on decisions made

Consensus helps decision-making

Having a good outcome at the end

Became open-minded

Did not like being spoon-fed information

More independent working at placement with less supervision

Repetition of tasks developed thinking in routine examinations

Own willingness and motivation to learn

Critical thinking is a life skill which you do not necessary develop at university

Learned to become critically reflective

Thinking required in simple versus complex situations/examinations

Pedagogy

Teaching and learning exercises to develop critical thinking

No encouragement to think critically

Tutors teach critically but do not often say 'this is critical thinking'

More problem-based learning, e.g. scenarios and case studies

A simple model is 'hammering a point, evidence and explain'.

Students struggle with reflection because it is a six-step process and it contradicts this model because analysis is positioned right at the end.

Challenges in developing critical thinking skills

More knowledge is required to make decisions in the second and third year

Need to try harder and look beyond the obvious solution

Felt intimidated by senior staff in the clinical environment so preferred to follow instructions rather than engage in the decision-making process.

No explicit teaching of critical thinking at university

Spoon-feeding expectation from students

Learning activities made no links with critical thinking skills development

Strong views of majority persons can prevent one from voicing their views or concern

Reluctance to contradict a qualified radiographer as a student

Instruction-led nature of the profession

APPENDIX 17: NVivo code sheet

Nodes

	Name
●	Attributes and dispositions
●	Change in perception of CT development
●	Change in understanding of critical thinking
●	Decision making
●	Definition of critical thinking
●	Problem solving
●	Analysis and evaluation of information or situations
●	Weighing options
●	Thinking
●	Effect of the complexity of tasks on thinking
●	Development of critical thinking
●	Challenges in developing critical thinking
●	Confidence
●	Positive feedback, motivation and encouragement
●	Role of clinical placement
●	Change in attitude and or perception of critical thinking
●	Theory to practice
●	Fit for purpose definition of CT
●	Importance of critical thinking to radiography
●	Outliers
●	Pedagogical implications
●	Reasoning
●	Reflection
●	Self-doubt
●	Student experience of participation in study
●	Tutor views on different forns of thinking
●	Tutors' meaning of critical thinking
●	Tutors' views on development of critical thinking
●	Tutors' views on pedagogy
●	Tutors views on relation of CT to purposeful, reasoned, reflective and ethical thinking
●	Tutors's view of importance of CT to radiography
●	Values and ethics

APPENDIX 18: Revision and consolidation of categories emerging from the initial coding on NVivo

Thinking
- the process of thinking
    - weighing the information for pros and cons
    - trust reliable sources
- different types of thinking
    - objective/ logical thinking
        - fact versus opinion
    - superficial 'everyday' thinking
- consequences
    - lack of confidence
        - accepting information as face value

- Different ways/ types of thinking/ thought processes
    - Instinctive/ intuitive thinking
        - Can do things without thinking
    - Emotional thinking
        - Consequences
    - Make sense of information
    - Situational thinking

- Meaning of critical thinking
    - Decision making
        - Evaluating information
        - Using reasons to make decisions
    - Thinking
        - Outcome or goal orientated
        - Deep vs superficial
        - Requires knowledge
    - Reflection
        - Self-questioning

Decision making
- The process of thinking leading to a decision
    - Using reliable reasons to balance arguments
        - Must see the full picture
    - Purposeful thinking, i.e. leading to a goal
    - Using past experience
- Complex decision – takes time
- Simple decision – is quick
    - Split decision without thinking
- Action taken as a result of the decision
    (This links with purpose and having a goal)
- Reflection on decisions
    - Making the right decision
        - Sense of achievement/ satisfaction
    - Indecisive
        - Consequences of a poor decision

Development of critical thinking

- Self confidence
  - Lack of self-confidence
    - Self-doubt
    - 'hard' to do
- Past experience
- Evaluate information
  - pros and cons
  - balanced view
- Time taken
  - Obvious decisions are quick
  - Complex decisions take time
  - Deliberate over decisions and over thinking
- Reflection
  - Consequences
    - Negative effect of patient outcomes
    - Situational influence in a busy hospital
- Ethics
  - Right/wrong
  - Moral obligation
- Consensus
  - Seek other people's advice for reassurance
  - Please other people
- Autonomy
  - Inconsistent support from radiographers
- Reasoning
  - Justification
  - Discretion
  - Content or intrinsic satisfaction
    - Assumptions
    - Rational
- Goals
  - Leading to an action
    - Prioritise
- Knowledge
  - Evidence
  - Reliable information

Pedagogy

- Teaching activities
  - Problem based learning scenarios
  - Case studies
  - Role play
  - The need to link subject matter with critical thinking skills
- Role of feedback from university and clinical placement
- Challenges
  - Critical thinking teaching being implicit rather than explicit
  - Student expectations (spoon-feeding)
  - Traditional practice of radiography
  - Institutional pressures
  - Tutors not fully understanding what critical thinking means

APPENDIX 19: Coalescence and evolution of themes

First phase student interview themes
- The process of thinking
  - Deep versus superficial thinking
  - Evaluating information
    - Factual evidence
      - Using reliable sources of information
    - Logical thinking
      - Using reliable reasons to balance arguments
  - Decision-making
    - Purposeful thinking
      - Simplex and complex decision
        - Outcome or goal oriented
        - Action taken as a result of the decision
  - Requires knowledge or past experience
  - Consequences
  - Lack of engagement
  - Reflection
    - Self-questioning
- Experience of learning at university
  - Deconstructing assignment briefs
  - Thinking in a more analytical sense
- Perceived clinical placement learning
  - Watching other people (radiographers)
- Developing through more practice, reflection, feedback and reassurance
- Requires
  - Knowledge and understanding
  - An open mind
  - Skills and dispositions

Second phase student interview themes
  - Problem solving
    - Simple versus complex thought process
    - Weighing options/evaluation
    - Rely on past experience/ previous learning/knowledge
      - Managing conflicting thoughts
  - Reasoning
    - Prioritising information
    - Moral reasoning
      - Weighing the risks and benefits
  - Making the 'right' decision
    - Taking the 'right' action
      - Consequences
      - Empathy
  - Reflection
    - Thinking on one's thinking (metacognition)
- Novice to expert growth and development
  - Going from naïve to a more sophisticated thinking
- Influence of clinical placement learning
  - Learning from working with patients

- o Learning from working with radiographers/ mentors
- o Theory to practice
- o Increase in awareness of moral/ethical dilemmas
- Decision making
  - o Reasoning
    - ▪ Informed decisions
    - ▪ From routine to complex
- Metacognition ('aha' moments)
- Influence of university learning
  - o No explicit teaching of critical thinking
- Challenges in developing and applying critical thinking skills

Third phase student interview themes
- o Deeper level of thinking
  - ▪ Broad scope of thinking
- o Decision-making
  - ▪ Thinking towards a goal
  - ▪ Evaluation of information
  - ▪ Reasoning or justifying thoughts or assumptions
    - • Impact of decision
- o Factors affecting change
  - ▪ Feedback
  - ▪ Placement learning
- Novice to expert development
  - o Consolidation of learning
  - o Knowledge and experience
- Role of clinical placement
  - o Theory to practice
- Decision making
  - o Reasoning/ cognitive skills development
- Disposition to think critically
  - o Open-mindedness
  - o empathy
- Metacognition
- Relationship between critical thinking and reflection

Tutor interview themes
- o Deep thinking process involving the evaluation of evidence
  - ▪ Purposeful thinking/reasoning
  - ▪ Goal or outcome based thinking
    - • To make a decision on what to do or believe
  - ▪ Ethical and moral reasoning
- o Reflection on thinking
  - ▪ Metacognition
- o Consequences/impact of decisions
- Student expectations
  - o Evolution of the role of the radiographer
- Scenario based teaching and learning exercises
  - o Develop the process of thinking and decision making
- Role of clinical placement
  - o Theory to practice

- Novice to expert learning
- Challenges
  - Learning and teaching exercises to develop critical thinking skills
  - Institutional pressures
  - Spoon-feeding expectation

APPENDIX 20: The final themes of the study

- ❖ **The meaning of critical thinking**
  - ➢ **Logical thinking involving analysis and evaluation**
    - o Evaluating information
      - ▪ Factual evidence
        - • Reliable sources of information
        - • Prioritising information
    - o Logical thinking
      - • Using reasoning to balance arguments
      - • Broad scope of thinking
      - ▪ Deep level of thinking versus superficial thinking
    - o Consequences
      - • Lack of engagement with the thinking process

  - ➢ **The process of decision-making**
    - o Purposeful thinking to make a decision
      - ▪ Simple versus complex thought process
        - • Outcome or goal oriented thinking
        - • Action taken as a result of the decision
    - o Problem solving
      - ▪ Requires knowledge/ past experience or learning
      - ▪ Weighing options/ evaluation
        - • Managing conflicting thoughts
      - ▪ Reasoning or justifying thoughts or assumption
    - o Moral reasoning
      - • Weighing the risks and benefit
      - • Making the 'right' decision
      - • Consequences of poor decisions
    - o Role of empathy in thinking
    - o Factors influencing change
      - ▪ Feedback
      - ▪ Placement learning

  - ➢ **Reflection and metacognition**
    - o Reflection
    - o Thinking on one's thinking (metacognition)
      - o Self-questioning
      - o Self-awareness
        - ▪ Reflexivity

- ❖ **The development of critical thinking**
  - ➢ **Role of university and placement learning – theory to practice**
    - o Role of feedback from assignments
    - o Learning and teaching activities
    - o Placement learning experience of working with patients
    - o Working with radiographer mentors

  - ➢ **Development of knowledge and understanding from naïve to complex understanding**

- o Role of feedback from radiographer mentors
- o Development of reasoning/justification skills
- o Process of decision-making in simple and complex tasks
- o Development of independent thought and autonomy

➢ **Challenges in developing critical thinking skills**
- o Need for teaching and learning activities to develop critical thinking
  - ▪ Activities were not linked with skills development
- o Student engagement and motivation
  - ▪ Student dependency
- o Evolution of radiography as a profession

APPENDIX 21: A description of the themes

➢ **The subthemes arising from the exploration of participants' understanding of the meaning of critical thinking**

    o **Logical thinking involving analysis and evaluation**

    During the exploration of the meaning of critical thinking, the participants attributed the process of weighing the pros and cons of an argument as critical thinking. In evaluating information, they considered reasons and available evidence in their thinking process.

    o **The process of decision-making**

    The participants spoke about critical thinking as a decision-making process where the outcome, goal or product of the thinking process was the decision. The thought process was perceived to be influenced by various considerations with respect to a patient's condition, for example, physical, emotional, moral/ethical considerations, as well as, in keeping the radiation dose as low as possible while obtaining a diagnostic image.

    o **Reflection and metacognition**

    The participants felt that reflection often led to an outcome which determined what action could be taken that may be different to the one taken before. This can happen during action (in action) and after action (post action), sometimes long after the decision was made. Thinking about their thinking is metacognition and is an act of reflection. According to the participants, the process of reflection involved analysis and evaluation; these are the cognitive skills of critical thinking. Critical thinking was therefore seen as integral to reflection and metacognition.

➢ **The subthemes arising from the exploration of participants' perceptions of the development of critical thinking over the three-year programme period**

    • **Role of university and placement learning - theory to practice**

    Students perceived that the feedback received from their university assignments helped develop their thinking abilities. Both students and tutors felt that the application of learning at clinical placement was instrumental in the development of critical thinking. In particular, students perceived the mentorship, feedback and reassurance received from clinical mentors

(qualified radiographers) to be a positive influence in enabling them to develop their critical thinking skills.

- **Development of knowledge and understanding from naïve to complex understanding**

    The learning gained at clinical placement enabled students' development of critical thinking skills from a basic understanding, in the first year of study, to a more sophisticated understanding in the third year of study. This is particularly evident in the description of their thinking processes in what they perceived as simple or routine examinations or situations compared with complex examinations or situations. Their responses concur with those of tutor participants. However, the novice to expert development is not a linear process, as evidenced by students. In an interesting journey of learning, students described how they transitioned from novice student to expert student when they became proficient in routine examinations, returning to being a novice in new examinations and more complex diagnostic procedures.

- **Challenges in developing critical thinking skills**

    Students and tutors felt that university sessions did not explicitly focus on critical thinking skills development. In addition, some student participants felt that they were "*robbed of the opportunity to think and make decisions*" when in the clinical environment. This was due to the expectation by some experienced radiographers that students should do as they were told.