

# **ANGLIA RUSKIN UNIVERSITY**

FACULTY OF HEALTH, SOCIAL CARE AND  
EDUCATION

## **SHEDDING NEW LIGHT ON MAGNETIC RESONANCE IMAGING PRACTITIONER EDUCATION: JACK OF ALL TRADES OR MASTER OF ONE?**

CATHERINE WESTBROOK

A thesis in partial fulfilment of the requirements of Anglia Ruskin  
University for the degree of Doctorate of Education

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*Do not follow where the path may lead.  
Go instead where there is no path and leave a trail.*

– Ralph Waldo Emerson, *Essay on Self Reliance*, (First Series, 1841).



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# ANGLIA RUSKIN UNIVERSITY

## ABSTRACT

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**SHEDDING NEW LIGHT ON MAGNETIC RESONANCE IMAGING  
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**Rationale:** MRI is a highly specialised imaging modality that uses non-damaging radiation to produce detailed medical images. In most countries, these images are acquired by practitioners who first train as radiographers and then specialise in MRI. Previous research suggests that some MRI practitioners may have insufficient knowledge to practise safely. This research proposes that practitioners should be educated initially and exclusively in MRI via a specialised undergraduate curriculum. This is underpinned by a proposition that the practice of MRI does not require an advancement of previously acquired radiographic knowledge, but instead reflects a difference in knowledge.

**Methodology:** As there are educational and professional implications to this research, a mixed-methodology approach is chosen. A convergent nested design with a dominant educational quantitative strand, supported by professional qualitative data, is used. Quantitative data are collected via an objective structured clinical examination (OSCE) to explore whether there is any difference in MRI knowledge between graduate and experiential practitioners. Graduate practitioners (n=25) learn MRI only via a specialised undergraduate degree. Experiential practitioners (n=23) learn only experientially post-qualification as a radiographer. Qualitative data exploring the professional implications of direct entry into MRI are collected via semi-structured interviews with key stakeholders (n=8). These are professionals who have either experience of graduate and experiential practitioners or an influence on policy in this area. The data from both strands are merged and analysed using a connections matrix.

**Findings:** Statistical analysis of the quantitative data shows that graduate practitioners score more highly in the OSCE at a significance of  $p < 0.05$ , especially in topics related to general principles of MRI, image contrast and image acquisition. The qualitative data support direct entry but raise concerns about limited scope of practice and registration.

**Contribution to knowledge:** This is the first study that considers whether the radiographic specialism is best learned initially and exclusively at undergraduate level and whether it is necessary to qualify as a radiographer to practise MRI. It is also the first study that uses a mixed-methodology approach to explore the feasibility of early specialisation in radiography.

Key words: education, specialism, imaging, MRI, radiography, mixed methodology.

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# CHAPTER 1: INTRODUCTION



## 1.1. RATIONALE

This research explores how best to educate magnetic resonance imaging (MRI) practitioners by investigating the educational and professional impact of direct entry into MRI practice via a specialised undergraduate degree without the need to first qualify as a radiographer.

MRI is a highly sophisticated diagnostic imaging modality that uses strong magnetic fields and radio waves to produce detailed images of the body to diagnose trauma or pathology. In most countries, including the United Kingdom (UK), these images are acquired by practitioners who first qualify as a radiographer and then learn MRI experientially. Undergraduate radiography curricula naturally focus on general radiographic imaging, and learning MRI is usually limited to basic theory and observing some routine examinations (Lombardo, 2006; Portainier, Castillo, and Portelli, 2014). Consequently, when individuals first enter MRI practice they usually require additional training, and this is commonly provided experientially by other MRI practitioners or manufacturer applications specialists. However, research suggests that this educational method is flawed, because the learning does not follow a standardised curriculum and is not formally assessed (Westbrook and Talbot, 2009; Castillo et al., 2016). Many who train new practitioners in the workplace have learned MRI experientially themselves and there is evidence that misunderstandings are cascaded and perpetuated (Allen, 2014). In addition, increasing automation of MRI scanning software does not tend to foster a deep understanding of MRI; therefore, even the most experienced practitioners often lack a sound understanding of the underpinning theory and find it difficult to make important connections between theory and practice (Caruana and Plasek, 2006).

In some countries, short taught courses are available to supplement experiential learning. In the United States of America (USA), there is a requirement in some states that individuals complete a short course based on an agreed curriculum followed by an examination, but this is not universal or compulsory (Castillo et al., 2016). In other countries, the availability of these courses is limited. Their content is not standardised and they are often delivered by individuals whose performance is not assessed (Castillo et al., 2016). There is, therefore, no harmonisation of this type of education and no formal assessment of its quality. Practitioners who wish to

undertake an academic programme of study in MRI are usually forced to learn at master's level, because they already possess an undergraduate degree in radiography. This is because specialism in a discrete area of practice, such as MRI, is consistently seen as something to be learned post-qualification. A few higher education institutions (HEIs) offer postgraduate programmes, but they are largely designed to allow practitioners who are already conversant in MRI to advance their knowledge. As only the basics of MRI are taught in undergraduate radiography programmes, prior understanding of MRI cannot be assumed; many students embarking on postgraduate programmes struggle to demonstrate academic mastery at the same time as learning a largely new and difficult subject (Westbrook and Talbot, 2009; Castillo et al., 2016).

There are, therefore, no universally agreed standards of training and education in MRI and there is no international coherency of educational provision (Castillo et al., 2016). Furthermore, there is very little available for practitioners who either wish to enter the profession from a non-radiographic background or are not suited to master's-level learning. In the USA and Canada, a small number of HEIs have developed specialised undergraduate programmes that enable practitioners who have not previously qualified as radiographers to graduate with a qualification in MRI (Castillo et al., 2016). However, there has been no research to date that assesses whether these practitioners are more knowledgeable than those who learn MRI experientially and, consequently, how important it is to first qualify as a radiographer. In addition, no one has explored the feasibility of introducing a similar model in the UK.

My research addresses these gaps by asking the question: *how do we best educate MRI practitioners?* It tests the hypothesis that it is better to educate MRI practitioners using a specialised undergraduate programme that leads to direct entry into MRI practice, because this offsets the weaknesses of other types of educational provision. The reasoning is that a common undergraduate curriculum could overcome the lack of standardisation of experiential models. In addition, learning MRI at undergraduate rather than postgraduate level might better align with the skills and competencies required of an MRI practitioner, especially when practitioners first enter practice. The implementation of this type of learning is, however, controversial, because it could avoid the need to first qualify as a radiographer, and it raises important questions surrounding the professional impact of such an intervention. At the heart of my research is a debate on specialist versus

generalist practice. Do practitioners who have entered MRI directly and focus on a discrete area of practice have a higher level of knowledge than practitioners who first train as radiographers and learn MRI post-qualification? Are practitioners who specialise only in MRI too limited in their scope of practice? Does direct entry into MRI fragment the radiography profession?

For the last 20 years, I have been one of the world's leading educators in MRI and at the forefront of developing a variety of MRI educational resources. I established the longest-running MRI physics course in the world, which I currently teach in 18 countries. I have also written three bestselling books on MRI, and I have developed and completed one of the first master of science (MSc) courses in MRI. In addition, I have taught MRI in undergraduate radiography curricula. Therefore, I have direct experience of MRI education at different academic levels. I have been on the boards of professional bodies responsible for regulating and monitoring MRI education and have influenced educational policy in several locations, including the UK and Ireland, Europe, the USA and Australia. Consequently, I am well placed as a researcher in this field.

In this chapter, I provide a reflexive account of the evolution of my research idea and explain the theory and propositions that underpin it. I also describe the journey I have taken as a researcher and the voice I use in this research. Finally, I set out the research questions and clearly demonstrate why this work is important.

## 1.2. DEVELOPMENT OF THE RESEARCH IDEA

The idea for my research is based upon my experience as an academic and a researcher in MRI. In particular, it draws upon previous research exploring the knowledge of a group of MRI practitioners, which exposed some potential problems with current educational methods (Westbrook and Talbot, 2009). The research idea was conceptualised using the model shown in Figure 1.1. The integration of my professional experience, previous research and personal reflection enabled me to visualise the genesis of this inquiry and identify why it is an important field of study.

**Figure 1.1. Developing the research idea**



### 1.2.1. Influence of my professional practice

This research has developed slowly over the course of my career. It is notable that the milestones of my professional journeys in radiography and academia, in practice and as a researcher, are reflected in this development. After achieving the Diploma of the College of Radiographers in 1981, I worked as a diagnostic radiographer in a London teaching hospital and in a district general hospital. During this time, my practice reflected a typical diagnostic radiography role in that it was diverse and multi-faceted. Not long after qualifying, I moved to a neurological and neurosurgery hospital and specialised first in computed tomography (CT) and then in MRI. I was instrumental in setting up one of the first MRI sites outside London, and shortly afterwards I further specialised in teaching MRI. The eventual specialisation of my career probably reflects my own desire to develop expertise in a defined, discrete area of practice, but its genesis was much earlier. Two years after qualifying, my first article (published under my maiden name) advocated that orthopaedic radiography be performed by specialist rather than generalist radiographers (Barbieri, 1983). Even at this early stage of my career I was showing interest in, and forming opinions on, how best to train radiographers in a discrete area of practice. It is interesting that 30 years later I am still involved in the specialist versus generalist debate and that this is a core theme of my research.

The transition from radiographer to someone who teaches radiographers began at the start of my career in MRI. MRI is a complex subject, which is underpinned by some very difficult physics. In the early days, there were no formal courses and books on MRI were largely written by physicists; therefore, they had a strong mathematical bias. Learning MRI involved deciphering equations; a difficult feat for many clinical practitioners, who commonly have a limited knowledge of physics. I studied this subject to a reasonably high level at school and was, therefore, able to teach myself the theory of MRI. In 1992, my learning was reinforced when I completed a Fellowship in Advanced MRI from the University of Philadelphia in the USA. At this point, I realised that I had the skills and knowledge to develop my own course in the UK. I started by teaching MRI to new practitioners at the centre in which I practised and then, more formally, taught MRI physics to small groups of local radiographers. I discovered that I have a gift for communicating difficult ideas by deconstructing them and converting them into easier, user-friendly bites of information. These skills enabled me to write a key book on MRI physics (*MRI in*

*Practice*), which was first published in 1992 (Westbrook and Roth, 1992). It has since become a leading text for MRI practitioners and is on the essential reading list for medical students, radiography students, radiologists and physicists at many leading universities and teaching hospitals. Two further books on MRI technique and physics followed shortly afterwards, and the MRI course developed into one that is now taught internationally.

From teaching the MRI course around the world, I became aware of the huge variation in educational models used to teach MRI and the consequent variation in knowledge of MRI. Although the course is largely didactic, there are many opportunities to assess delegates' knowledge through questions and answers, informal quizzes and revision sessions. It became evident that a substantial number of attendees had a limited understanding of key MRI concepts and their knowledge did not necessarily follow their level of education or experience. For example, someone who had completed a postgraduate course in MRI did not necessarily know more than someone who had learned MRI through ad hoc training. Practitioners who had been practising MRI for many years did not necessarily know more than someone who had only just begun their career in MRI. This was reinforced by research that a colleague and I undertook for the Department of Health in 2007 (and published in 2009) assessing the MRI knowledge of a number of MRI practitioners. This research highlighted a large variation in levels of knowledge and suggested that this may be caused by flaws in current educational models (Westbrook and Talbot, 2009).

In 2004, I left clinical practice and became a full-time senior lecturer in MRI at Anglia Ruskin University. My affiliation with the university began in 1995, when I developed the curriculum for one of the first MSc courses in MRI in the world. I was an external advisor for many years and was involved in assessing MRI-specific modules. Since 2004, I have been the course leader and seen the course improve through many modifications and re-validations. I have also taught MRI in some undergraduate radiography programmes in the UK and have been the course leader in master's programmes in radiography, CT and radiotherapy, and an external examiner in postgraduate MRI courses, at many other universities. Reflection on my experiences is that students find studying MRI at postgraduate level far more challenging than they find studying radiography at the same level. The attrition rates in the MRI pathway are much higher, and a larger percentage of students fail to succeed, regardless of their experience or the level at which they

practise. I believe that one of the reasons for this is that MRI students face more challenges than radiography students, because they are learning something entirely new and complex. By contrast, radiography students are advancing knowledge that they have largely already acquired at bachelor's level; consequently, they find studying at master's level less challenging.

The idea that undergraduate-level learning might be more appropriate emerged when developing an undergraduate programme in ultrasound in collaboration with the University of Queensland in Australia. There are several parallels between this specialised imaging modality and MRI, and the rationale for direct entry into the profession is similar. Neither modality uses damaging radiation, and the theory that underpins them is very different from that which underpins radiography. The University of Queensland took steps to create a specialised undergraduate degree in ultrasound that bypassed the need to first qualify as a radiographer. This initiative set a precedent that was a springboard to explore a similar approach in MRI.

### **1.2.2. Influence of the literature**

A detailed exploration of the literature is provided in Chapter 2. This reveals a lack of research into whether MRI, or, indeed, any imaging specialty, needs to be taught differently. There is some research on educating specialists in nursing and a limited amount in radiography, but it all focuses on acquiring knowledge post-qualification at postgraduate level. This might be because in professions like nursing there is a presumption that primary knowledge learned at undergraduate level can be translated into specialist areas. This is not the case in MRI, where there are very few commonalities with general diagnostic radiography. In fact, most of the literature reflects the assumption that specialism is always an advancement of knowledge and practice in terms of the development of an expert practitioner (White and McKay, 2004; Ferris, 2009). The specialist versus generalist debate in healthcare is a central dialogue that underpins my research. This is a substantial topic and it is important, because how specialism is defined dictates how specialists are educated. For example, if specialism can be seen as sometimes reflecting a difference rather than an advancement of knowledge, undergraduate rather than postgraduate education could be appropriate.

The idea that undergraduate programmes might be a better way of educating MRI practitioners materialised from a mapping exercise of key policy documents on radiography that offer complementary perspectives on competence and level of practice. A number of agencies have established educational and clinical benchmarks in diagnostic imaging. These include specialty-specific competency standards and performance indicators for each type of radiographic practitioner. In 2008, I was part of a team that developed a set of competencies for MRI practitioners. These standards are prescriptive statements that outline good practice for those acquiring MRI images for diagnostic purposes. The competencies reflect a paradigm against which performance can be measured. There is very little emphasis on the areas of reflection, evidence-based practice and decision-making. Nonetheless, they arguably represent what an MRI practitioner needs to be able to do to practise safely and competently at a minimum level (Skills for Health, 2008).

By contrast, publications from the Society and College of Radiographers (SCoR) on the educational and professional development of radiographers (2010) and on learning and development frameworks (SCoR, 2008; SCoR, 2013a) emphasise the need for practitioners to possess a variety of skills, which are not confined to basic competencies, even at the lowest level. These include autonomy, accountability and reflection. The SCoR publications attempt to set out the roles and responsibilities of each professional tier and identify what type of education is required to enable these to be achieved. Those in possession of an honours degree in radiography are titled *practitioners* and their primary role is to conduct a broad range of diagnostic examinations. The SCoR infers that it is only once the practitioner's preceptorship is over that they can consider developing specialist skills (SCoR, 2008; SCoR, 2013a). Interestingly, the SCoR's guidance on what constitutes a specialist area of practice does not include MRI.

*Advanced practitioners* are defined as either innovators who have developed specific expertise (SCoR, 2013a) or, conversely, those whose roles reflect a broad range of clinical settings (SCoR, 2010). Research commissioned by the SCoR highlights the scope of what may be considered advanced practice and acknowledges that advanced and specialist titles might both be appropriate. The waters are further muddled by the use of the phrase *advanced specialist practitioner* (SCoR, 2010). In either case, the differentiators between practitioner and advanced practitioner level are mainly concerned with complexity, leadership and developing new practice (SCoR, 2013a).



In 2009 the Council for Healthcare Regulatory Excellence (CHCRE) produced a report for the four UK health departments. The report attempts to clarify the terms *advanced* and *specialist* practice with the aim of evaluating whether titles have registration implications. The CHCRE determined that advanced practice should reflect the slow evolution of practice, knowledge and skills so that the practitioner becomes more autonomous and more capable of dealing with complex problems. It suggests that specialist practitioners are more suited to a professional specialisation in a specific area, without necessarily implying that their level or depth of knowledge is advanced (CHCRE, 2009).

The discrimination between these terms is important to my area of study. The current educational strategy for radiography provides a framework for only postgraduate study in specialist areas, such as MRI. This implies that the knowledge gained is an advancement of primary learning rather than newly acquired knowledge. The Quality Assurance Agency (QAA) for Higher Education (2008) stipulates that when developing master's curricula, academics should assume that prospective students already have background knowledge acquired through study at bachelor's level or substantial experiential knowledge. However, this is usually not the case in specialist imaging areas, such as MRI, which is possibly one of the reasons why students often find postgraduate MRI programmes challenging.

Table 1.1. (p.11) sets out the themes that emerge from exploring these policies by connecting the award descriptors of the QAA (2014), the Skills for Health *National Occupational Standards in MRI* (2008) and the SCoR *Education and Career Framework for the Radiography Workforce* (2013a). The purpose of this exercise is to see if there are any links between the skills required of a safe and competent MRI practitioner (as defined by Skills for Health, 2008), the learning outcomes of a practitioner and advanced practitioner (as defined by the SCoR, 2013a) and the QAA undergraduate and postgraduate level descriptors (2014). This mapping is based on a pragmatic and judicious blend of cognitive, experiential and career-progression paradigms. In Table 1.1., action words associated with knowledge, understanding and application are marked in blue, and those linked to increased complexity and criticality are marked in red.

**Table 1.1. Policy document mapping exercise**

	Skills for Health national occupational standards	SCoR learning outcomes – practitioner	QAA descriptors (undergraduate)	SCoR learning outcomes – advanced practitioner	QAA descriptors (postgraduate)
<b>Knowledge</b>	<b>Understand</b> how to acquire magnetic resonance images for diagnostic purposes. Includes <b>knowledge</b> of physics, anatomy and safety.	Develop skills, <b>knowledge</b> and <b>understanding</b> to perform their roles within an evidence-based framework.	Develop an <b>understanding</b> of a complex body of knowledge, some at the <b>current boundaries of knowledge</b> .	Develop <b>specialist knowledge</b> or breadth of knowledge and understanding through active engagement with the evidence base.	Develop an understanding of a complex body of knowledge informed by the <b>forefront of knowledge</b> .
<b>Application of knowledge</b>	<b>Understand</b> correct and safe use of equipment associated with image acquisition.	Transfer <b>knowledge</b> and <b>understanding</b> to situations encountered in practice. Recognise and <b>apply</b> relationships between learning developed in university and practice-based environments.	Be able to evaluate evidence, <b>knowledge</b> and arguments and assumptions and reach sound judgements.	<b>Critically evaluate</b> and <b>apply knowledge</b> and <b>understanding</b> in their own areas of practice. <b>Apply</b> knowledge, understanding and skills to <b>complex and challenging situations</b> .	Be able to show <b>originality</b> in the application of knowledge and be able to <b>advance knowledge through research</b> .
<b>Problem-solving</b>	<b>Understand</b> common normal variants and their appearances. <b>Understand</b> when additional images are required to aid diagnosis.	<b>Apply</b> problem-solving skills to <b>routine</b> situations and adapt to different work settings within their professional area.	Develop <b>analytical</b> techniques and problem-solving skills.	<b>Synthesise and critically appraise</b> material from diverse or complex sources.	Be able to deal with <b>complex</b> issues and show <b>creativity and originality</b> in solving problems.
<b>Professional characteristics</b>	<b>Understand</b> personal level of competence and authority and when to seek assistance.	Demonstrate an ability to reflect on practice.	Be able to exercise personal responsibility.	Develop and review approaches to their own practice.	Be able to exercise personal responsibility.
	<b>Understand</b> how and from whom to obtain additional information to assist with decisions regarding procedures.	Access and <b>apply</b> an evidence-based approach to practice.	Be able to make decisions in <b>complex and unpredictable</b> professional environments.	<b>Exercise clinical teaching and leadership skills</b> in their chosen field.	Be able to show <b>initiative</b> in solving problems in <b>complex and unpredictable</b> professional environments.

In Table 1.1, the knowledge, skills and outcomes of a competent MRI practitioner, which are benchmarks of the Skills for Health national occupational standards in MRI (2008), seem to map more effectively to the QAA undergraduate descriptors than to the postgraduate descriptors. They also better align with the expected learning outcomes at practitioner rather than advanced practitioner level, as described by the SCoR.

My reading also included an exploration of suitable theories on which to base my research; these are explained and justified in detail in Chapter 3. The most appropriate seemed to be the ones that link levels of thinking and learning to skills and competencies. Bloom's taxonomy is an obvious contender, as it is a sequence of progressive contextualisation of knowledge. Bloom categorises three different thinking behaviours, each of which is divided into different levels of learning (Anderson et al., 2001). The taxonomy shows a hierarchical structure of knowledge, with higher levels of abstraction at the top and lower levels at the bottom. This theory is used extensively in the development of curricula to map the educational level of the programme to the required outcomes. In addition, Benner's (1984) novice-to-expert continuum, well known in nursing circles and based on the Dreyfus skills-acquisition model, connects the knowledge and clinical skills required to progress from a beginner to a proficient healthcare practitioner. This theoretical construct describes five stages of clinical proficiency, where progression from one stage to the next is based on the acquisition of higher levels of knowledge and experience.

In Chapter 3, I link these theoretical constructs with the policies mapped in Table 1.1. I explore correlations between each level of Bloom's, Benner's and the Dreyfus hierarchies and show how Bloom's three lower levels (which are often mapped to a three-year undergraduate programme) link well with the equivalent levels of Benner and Dreyfus, where a practitioner moves from being a novice to being a competent practitioner. These connections strengthen my idea that MRI might be best taught at undergraduate level, because undergraduate curricula are designed to enable competent, rather than expert, practice. The policy-mapping exercise shown in Table 1.1., combined with the theories of Bloom, Dreyfus and Benner, which are explained in Chapter 3, appear to justify the proposition on which this research is based. Undergraduate, rather than postgraduate, curricula map more successfully to the skills and competencies required of an MRI practitioner, particularly at practitioner or entry-level practice.

### 1.2.3. Influence of personal reflection

Although I had a good idea from the start of what I wanted to research, I found it harder to specify the exact problem I wanted to investigate. This research topic is significant and it potentially addresses a wide range of concepts that fall within educational and professional domains. This fits well with the general aim of undertaking a professional doctorate, where emphasis is placed on contextualising research within the education profession, and it widens the scope for what areas are researchable. For example, the educational aspects of my research could include how best to gain and retain knowledge to practise MRI competently and how curricula enable this learning. These educational perspectives invoke debates that could have far-reaching implications for the radiographic profession. They include whether practice in early specialisation fragments the radiographic profession, what the core skills of a radiographer should be, and whether it is necessary to be a radiographer to practise in a specialty, such as MRI. Taken further, the dialogue on how specialism is taught in other healthcare professions widens the scope of this topic even further. For example, in CT, evidence is emerging that lack of education is leading to dangerously high radiation doses (Heads of European Radiological Protection Competent Authorities, 2014).

Silverman (2006) warns against defining a research problem too widely. A broad research topic can mean that the researcher is unable to see what data are required to answer the research question and, consequently, cannot say anything of great depth about it (Punch, 2009). The research problem must be clearly framed, relatively narrow and, therefore, manageable. As Silverman eloquently puts it, 'your aim should be to say a lot about a little problem. Avoid the temptation to say a little about a lot' (2006, p. 5). However, Silverman also warns against allowing a research topic to be too narrowly confined to problems generated by professional groups or institutions. This is because different disciplines inevitably impose their own theoretical or methodological perspectives on research. Silverman claims that it is better to begin from a specific social science perspective, as this frees the researcher to address discipline-orientated problems later on with 'considerable force and persuasiveness' (2006, p. 18).

I believe that I have avoided the trap of defining my research purely from a professional problem-based perspective. Although it has profound implications for

the radiographic profession, its genesis lies in what I see as a general problem with how MRI practitioners are educated. Its roots lie in the belief that something needs to change, that current educational models are too diverse, and that some of these models may be sub-optimal in terms of enabling safe and competent practice. However, the professional implications are important. Research into the best way to educate an MRI practitioner would be incomplete without considering the wider professional implications of a new educational intervention. The concepts linking the educational and professional domains of this study are how specialism is defined and whether imaging specialisms represent a difference or an advancement of practice. This is because these central abstractions influence the most appropriate level at which to educate MRI practitioners in addition to how early specialism is viewed by the radiographic profession and the professional and regulatory bodies.

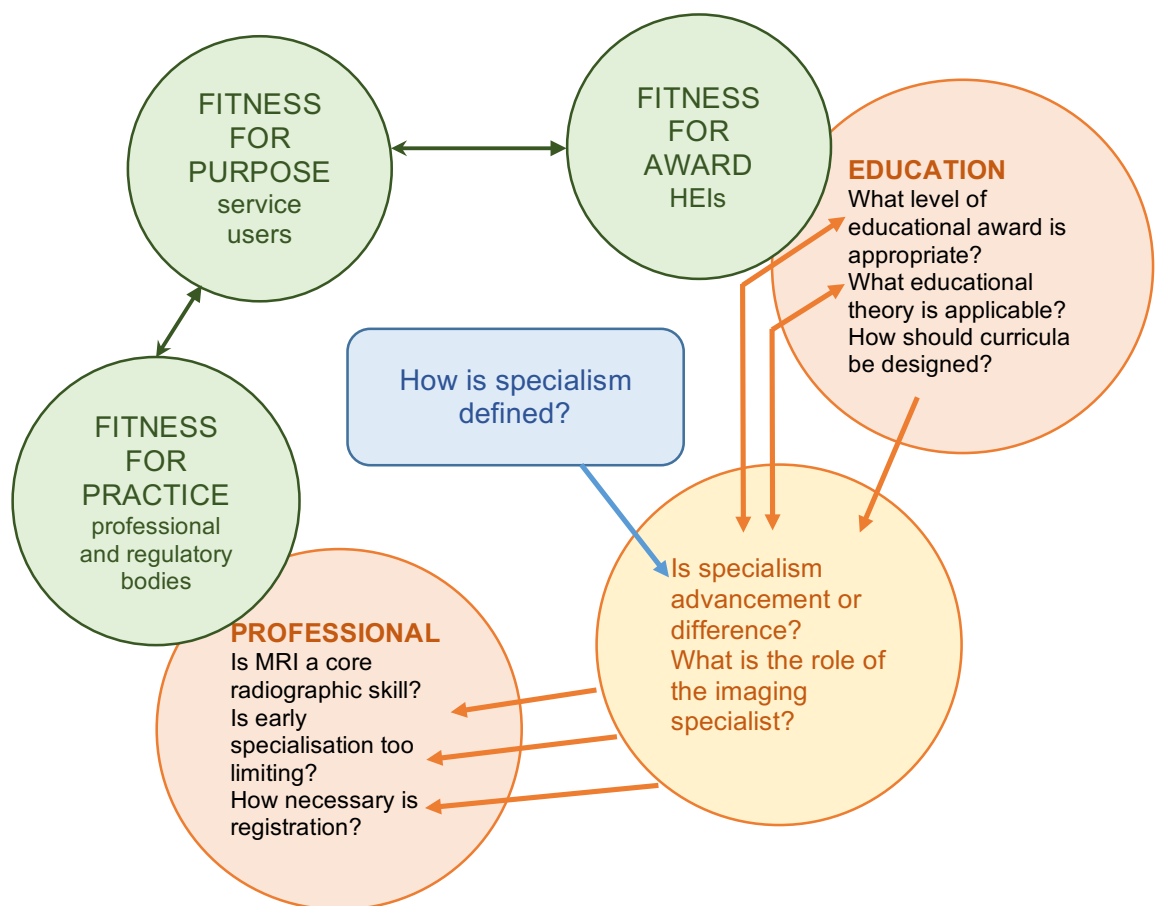
### 1.3. RESEARCH PROPOSTION AND THEORY

The central research problem is that previous inquiry has identified possible flaws in current methods of educating MRI practitioners. There may be a misalignment between the level of educational provision and the skills and competencies required for safe practice (Westbrook and Talbot, 2009). There is also a lack of standardisation and regulation of education and a lack of assessment of competencies in MRI (Castillo et al., 2016). Finding the best way to educate MRI practitioners is important, because their practice has a direct impact on patient safety. Whilst automated software allows MRI practitioners to acquire images on a very basic level, many struggle with the theory that underpins MRI and how to apply this theory effectively to practice (Caruana and Plasek, 2006). This is commonly revealed in a lack of understanding of imaging parameters and of how to modify them for particular patients and pathologies (Westbrook and Talbot, 2009). It also emerges in an inability to recognise abnormal image appearances and a lack of skill in improving image quality (Westbrook and Talbot, 2009). This is seen to be important from many perspectives. Firstly, it can result in misdiagnosis and the need to recall patients for scans, increasing anxiety and healthcare costs. In addition, in some instances a lack of theoretical understanding leads to unsafe practice (Greenberg, Weinreb and Shellock, 2011). MRI involves the use of very strong magnetic fields, which can cause serious injury or death to patients and staff. Therefore, it is essential that practitioners are fully conversant with MRI safety issues and have acquired a deep understanding of the underpinning theory (Shellock and Crues, 2013).

I have used a concept put forward by Smith (1998), which I have called the *fitness framework*, to clarify the themes of my research and frame the research questions. This asserts that there is a disconnect between what employers require a practitioner to do (fitness for purpose), what professional and regulatory bodies require of that practitioner for registration (fitness for practice) and what HEIs require to validate an educational programme (fitness for award). If the development of initial and exclusive MRI specialist education is the answer to deficiencies in current educational strategies, these three concepts must be reconnected in a meaningful way. Figure 1.2. (p.16) conceptualises the researchable themes and their connections using the fitness framework. It is evident that how specialism is defined plays a pivotal role in the educational and

professional aspects of this study. The fitness framework is embedded into this conceptualisation, and service users (primarily patients, but also employers) are placed at the centre. It is important that HEIs and professional and regulatory bodies are all accountable to employers and patients, that HEIs educate practitioners who are skilful, and that regulatory professional bodies regulate practitioners who are competent and safe to practise. I believe that placing patient safety at the heart of my research adds weight to its importance and significance.

**Figure 1.2. Conceptualising the research themes**



This research is framed by the following questions. Which educational system is best? Is it the traditional method of non-standardised, experiential training or are patients and employers better served by practitioners who learn MRI via a common undergraduate curriculum? Does it matter to the profession whether practitioners are first educated as radiographers? How important is it that MRI remains a core skill of a radiographer? Does early specialisation in MRI limit the scope of practice of practitioners to such a degree that it has an impact on their usefulness in an imaging department? In Chapter 7, I return to the fitness framework and re-valuate this concept and these questions in the light of my research findings.

Clearly, my research cannot focus on whether direct entry into MRI is a good idea from an educational perspective only. This inquiry would be incomplete without considering the professional impact of early specialisation. Therefore, the research questions are constructed to address both aspects of this problem, reflecting a mixed-methodology approach. They are summarised in Table 1.2. and they are discussed and justified in detail in Chapter 3.

**Table 1.2. The research questions**

How do we best educate MRI practitioners?		
What is the relationship between the educational level at which a practitioner learns MRI and their residual knowledge of MRI theory?	What are the professional benefits of, and barriers to, early specialisation in MRI?	To what extent do the educational and professional perspectives explored in this study support the introduction of a specialised undergraduate degree programme in MRI?
Educational, quantitative question	Professional, qualitative question	Mixed-methodology question



## 1.4. THE RESEARCH VOICE

My research identity developed early and I have been an active researcher for most of my career. I published my first article in 1983 and, although this was a discussion article rather than empirical research, it enabled me to gain insight into writing for publication. It is also worth noting that the views aired in the article are quite contentious; even at such an early stage of my career I was not afraid to raise controversial issues. Since then, I have been sporadically but consistently research-active. I have solely or collaboratively written more than 20 peer-reviewed articles, one of which was published in *The Lancet* (Kennedy et al., 1998). Some are discussion articles, whilst others are based on primary research using mainly quantitative methodologies. Although I might be considered rather a prolific author and researcher, my formal knowledge of research before starting this inquiry was limited.

What type of professional researcher am I? Am I approaching this research as a radiographer, as a teacher who educates radiographers, or as a researcher? I believe that my professional identity is now that of an academic rather than a radiographer, but I am still attracted to research that influences the radiographic profession. In general, resources written specifically by radiographers have far greater resonance for me than those written by academics. This is possibly because my educational practice is exclusively embedded in radiography. There are professional criteria that are common to teaching and radiography; namely, expert knowledge, autonomy, altruism, accreditation and regulation (Nixon, 2000; Sim and Radloff, 2009). I think the difference lies in the role that research plays in each profession. There may also be further differences between academics from healthcare backgrounds and those who are purely educationalists.

Although some radiographers have an appreciation for research and can translate the research of others into their practice, relatively few radiographers undertake research themselves (Payne and Nixon, 2001; Williams, 2013). By contrast, there is an established opinion that teaching is a research-based profession and there is an expectation of consistent scholarly activity (Hedges, 2010). Academics in higher education are likely to be immersed in a research community; therefore, they can carve out a unique identity within that community. Nonetheless, Williams (2013) claims that many academics in the allied health professions, such as radiography,

come from the pre-graduate scenario where there is no requirement to undertake research; as such, they find the move from clinical practice to academia quite difficult.

I have always been resistant to researching for the sake of it. The notions that professionalism is about creating new knowledge and only active researchers undertaking primary research can be considered true professionals (Sim and Radloff, 2009) is one that I reject. Not only does it cultivate a divisive and unhelpful hierarchy but I do not believe that it truly represents professionalism. However, there is merit in Marshall's (2008) claim that academics must act as role models to their students by being active researchers, and I appreciate that the creation of new knowledge is an essential part of this. Understanding research is not just about knowing how to 'do it' but is a state of mind, which can only be cultivated over time. Jove (2011) places emphasis on the fact that being a teacher-researcher is a process, not an 'end in itself'. She cites several examples of her own practice, where she uses the process of *becoming* to demonstrate her ability to reflect, embed herself in her practice and, thence, initiate change. In defining becoming, Jove (2011) argues that we should see ourselves as a work in progress and that our ability to grow and develop a research mind-set is a never-ending process.

Ridley (2011) critically appraises the concept of research capacity-building, which involves the slow and steady development of a research mind-set amongst academics. She claims that, in addition to developing sound research knowledge, researchers need to have the courage to advance this knowledge and push forward controversial changes. This argument strikes a chord in that having the courage to 'rock the boat' is seen to have merit in the research arena. Some of my publications have put forward rather contentious views. For example, in an article entitled *Radiography education* I challenged the accepted view that studying at undergraduate as opposed to diploma level produces more competent radiographers (Westbrook, 1991). In another, *MSc qualification – necessity or nuisance?* I challenged the appropriateness of studying MRI at postgraduate level (Westbrook, 1992). Although this attracted criticism during the transition from diploma to degree education in radiography, my ideas began a very important dialogue, some of which has influenced the development of this research topic.

The notion of becoming (as cited by Jove, 2011) and Ridley's (2011) concept of research capacity-building both resonate with my evolution into a more confident

teacher-researcher. My professional practice, experience and research as an academic and a radiographer have propagated and framed my research idea. The development of this idea into a robust conceptual framework and research design has enabled me to improve my understanding of the research process significantly. It has also broadened my research perspective; it has strengthened my appreciation of qualitative methodologies and alternate epistemologies. Undertaking this research is another stepping stone on my journey as an emerging teacher-researcher who has a unique identity and some important contributions to make to her professional practice. It is this voice that I bring to this research.

## 1.5. CONCLUSION

In this chapter I give a coherent, reflexive account of how my professional journey as a radiographer and an academic has informed my chosen research topic. I contextualise my research and frame the key constructs and themes that I have used to develop my research idea, and I set out clear research questions.

This thesis is structured to take the reader on a logical journey through my research. It consists of the following.

*Contextual chapter:* In Chapter 2, the literature is used to frame the research idea and justify the propositions I have made. A review of the literature is part of this chapter but, due to the paucity of research specific to this field, the literature is mainly used to contextualise the themes of my research.

*Design chapter:* Chapter 3 explains how the research questions align with the philosophical and theoretical perspectives I have adopted and the methodology and methods I have used. This chapter explains and justifies a mixed-methodology approach and conceptualises the research design.

*Methodology chapter:* Chapter 4 describes and justifies the methodology and methods I have used to collect and analyse the data. In addition, it articulates the limitations of my research in terms of generalisability, validity and reliability. The ethical considerations of my research are also described.

*Findings chapter:* Chapter 5 illustrates and explains the quantitative and qualitative data. Tables and line graphs are predominantly used in the quantitative section of this chapter to demonstrate the main findings of this strand of the study. Tables and excerpts from transcripts are used for this purpose in the qualitative section.

*Discussion chapter:* Chapter 6 separately analyses the quantitative and qualitative data. Both types of data are then merged using a connections matrix to highlight the congruencies and discrepancies across the data. The analysis directly addresses all three research questions and the research hypothesis. This chapter also revisits the limitations of my research in the light of its findings.

*Conclusions chapter:* In Chapter 7 the findings and recommendations of this research are summarised, the themes are discussed and suggestions for further research are made.

Key documents can be found in the appendices.

An important consideration in the development of my research idea has been my influence in the field of MRI and what impact this might have on my research. For example, the experience I have in MRI education could introduce unconscious bias and influence how I design and conduct my research. However, the same prominent role has, I believe, provided me with a unique insight into the issues and an opportunity to influence policy. Brannick and Coghlan (2007) present a convincing argument that sitting inside one's research and being close to it enables better research inquiry. I consider that this insider viewpoint is important in this area of research in that it enables me to identify a clear and distinct problem with current educational models. My professional experience has exposed me to a range of educational paradigms, which have led to this unique research idea. However, it is also important to recognise that the same professional experience has led me to the proposition that a specialised undergraduate degree may be a better way of educating MRI practitioners. In acknowledgement of this, sampling and data-collection methods are selected to reduce bias as much as possible. However, throughout my research I consistently take a critical stance, which appreciates that there could be many factors that influence my findings.

My research idea is original and significant. It is a topic that not only matters to me on a personal level but also may be relevant to other specialists in healthcare. It has emerged from an integration of my lived experience as an MRI practitioner and educator and an examination of previous research on specialist practice. Paterson (2012) claims that the radiographic profession and the way in which radiographers are educated are ready for a paradigm shift. I believe that my inquiry is perfectly placed to influence this change.

Throughout my thesis, I have chosen to write in the first person and mainly in the present tense. This style, I believe, encourages a reflective and reflexive approach and, I hope, helps to engage the reader in this work.

## CHAPTER 2: CONTEXT

## 2.1. INTRODUCTION

The aim of this chapter is to contextualise and justify my research topic and demonstrate why it is important. This builds upon an initial review of the literature provided in Section 1.2.2. It closely frames the central topic of my research (how best to educate MRI practitioners) and draws attention to the research contribution. My inquiry touches on a wide variety of issues, and the specialist versus generalist debate, specialist education and professional practice feature prominently. Little has been written about specialism in radiography, and nothing has been written specifically about specialism in MRI. Therefore, the focus of this chapter is to explore what the literature says about the issues that surround this topic. The literature is used to ground this study in the work of others, but its main purpose is to provide a contextual framework for the subsequent chapters. Research in nursing, midwifery and medicine is frequently referenced and supported, where it exists, by research in radiography.

I conducted an initial literature search using PubMed and EBSCOhost, including CINAHL, CINAHL Plus with Full Text, Academic Search Premier, and Medline. I conducted all searches through the Anglia Ruskin University online library. I used the following search terms during initial scoping of the literature; *magnetic resonance imaging (and MRI) education, radiography education, specialism, specialist practice (healthcare and radiography) and specialist education (healthcare and radiography)*. After this scoping exercise, more specific themes emerged and I refined the search terms to include *generalist versus specialist debate, multi-competency in healthcare and advanced and specialist practice (healthcare and radiography)*. I used NVivo for Mac (version 10.2.2) to extract and identify common themes and compare them to other instances of similar themes across the literature. This helped me to appraise the key questions that my research needs to address and the most appropriate methods to use (Gregorio, 2000).

There are several articles and comments in journals and conference abstracts on aspects of advanced and specialist practice in medicine, nursing and radiography. However, there is a lack of systematic documentary evidence for the best way to educate specialists in a discrete area of practice. Many of the publications focus on assessing the professional roles of advanced and specialist practitioners, and it is

evident that confusion exists over how best to define and differentiate between specialist and advanced practice in most healthcare professions. Other themes address the political, clinical and professional tensions of specialism, many of which form part of the specialist versus generalist debate. Most of the radiographic literature on specialism is either based on descriptive data or informed by literature review, and it is largely historical. If specialism is mentioned in radiographic research, there is an assumption that specialists are advanced or consultant practitioners exhibiting higher-order skills that go beyond general clinical practice, rather than practitioners who work in a discrete area of practice (Price, Edwards and Hazel, 2008; Smith et al., 2008; Ford, 2010; James, Beardmore and Dumbleton, 2012).

Two studies on specialist practice in radiography by Ferris (2009) and White and McKay (2004) are referenced at several points in this chapter. Ferris (2009) used ethnographic and historiographic methodologies to construct a biography of radiographers' perceptions of specialism. Semi-structured interviews involving 21 participants were undertaken during a 12-month period in 2000 and 2001. The article was not published until 2009; therefore, Ferris' claim that her findings represent a contemporary history of specialism are not particularly convincing. Since the study was conducted, there has been a huge expansion in the clinical use of specialist modalities, including MRI, and there have been major changes in the expected scope of radiographic practice (SCoR, 2013c). Nonetheless, Ferris' article provides a useful insight into the views of a small group of specialist and non-specialist radiographers, and it has helped me to thematise the core issues surrounding this topic. In another study, White and McKay (2004) conducted an extensive literature review and, therefore, their conclusions may have more validity than those of Ferris' rather limited perspective. They reviewed more than 80 articles, mainly published in the 1990s and early 2000s, in the nursing and radiography professions. The issues they explored included role extension and expansion, specialisation and multi-competency, the use of the specialist title, and the education and accreditation of specialists.

Investigation into issues surrounding direct entry into a specialist imaging modality challenges what specialism means in the context of MRI. The concept of whether specialism is defined as a difference or an advancement of knowledge and practice is important, because how it is defined determines how it is best to educate MRI practitioners in terms of level and content (Anderson et al., 2001). If knowledge and



practice in MRI reflect an advancement of previously acquired radiographic knowledge and the development of complex skills and behaviour, postgraduate-level study might be appropriate. However, if it represents different knowledge and practice from that of general radiography, it is possible to argue that undergraduate curricula are the best fit (QAA, 2014). This, in turn, has professional and registration implications for those who specialise in MRI and for the radiographic profession in general. In this chapter, I provide a critical and evaluative account of what has been published on these topics and, in doing so, establish the general themes of my research.

## 2.2. HOW IS SPECIALISM DEFINED?

To determine whether practice in MRI reflects a difference in, rather than an advancement of, general radiographic knowledge, it is necessary to try to discriminate between specialist and advanced practice. The literature reveals that there is a clear disparity between the professions on how specialism is defined. Some see specialism as relating to practising in a focused area, whereas others identify it as having skills that are beyond those required for general practice (CHCRE, 2009). In some professions, the term *specialist* is used to represent level and focus of practice, whilst in others it is used to denote focus separately from level. For example, in nursing, there is an established use of the term *specialist* to describe roles at all levels where nurses specialise in one area of practice, but this can vary according to several criteria. These include the age of nurses' patients, the degree of illness, the activities the nurses perform, and whether they work in a specialist institution (Castledine, 2004).

In 2009, the CHCRE was commissioned by the Department of Health to clarify the terms *advanced* and *specialist* practice with the aim of evaluating whether the terms have registration implications. The CHCRE claims that there are significant differences in the ways in which these definitions are used. The CHCRE interprets specialist practice as working in a specific area of practice or working at a level beyond that of general practice (CHCRE, 2009). Advanced practice is defined as a continuum of increasing knowledge, skills and behaviours evolving into situations that are more complex and with greater autonomy and accountability (CHCRE, 2009). However, other authors, such as Price, Edwards and Hazel (2008), are less clear and believe that whilst advanced practice can mean this, it can also reflect developing expertise in specialist areas of practice.

Specialist practice is even harder to define in radiography, where the term *specialist imaging modality* is used to differentiate modalities, such as MRI and CT, from general radiographic examinations. There is further confusion, as radiographers, X-ray technicians and medical radiation practitioners all perform very similar functions (Cowling, 2013). In some countries, for example, the USA, radiographers are called technologists. They are differentiated from technicians, who might have the knowledge and skills to maintain equipment but, unlike technologists, are not usually educated to degree level (Young, 2008). MRI

practitioners fall under the technologist umbrella, because their roles bridge technology and medicine (Belinsky et al., 2003). Ferris (2009) asserts that other healthcare professionals consider radiography to be special and exclusive. A contributory factor is that, for safety reasons, X-ray and magnetic fields require clear demarcation. Consequently, there are visible practice boundaries, which might imply exclusivity. In addition, many working practices have been driven by advances in computer technology, with radiographers demonstrating an aptitude for emerging modalities that use this technology. MRI is an example of new technology being associated with specialist imaging (Hardy and Snaith, 2006). However, computerised technologies have now had a substantial impact on all types of medical imaging and on other areas of healthcare. Consequently, attitudes towards links between technological expertise and specialist status have gradually changed (Hardy and Snaith, 2006).

The perspectives of radiographers explored in the research by Ferris (2009) reveal that specialism is connected to the dedication and focus of the radiographic role. Specialists are regarded as being knowledgeable and expert in their field, and MRI is considered an area of specialist practice. There is also recognition that specialism is hard to define. This is because some practice areas, although deemed special to some, are not regarded as such by others if the same practice forms part of everyday work (Ferris, 2009). White and McKay (2004) muddy the waters even further by claiming that it is not uncommon for radiographers to be specialists in two or more areas. They question whether, under these circumstances, advanced practice is a more appropriate term.

The literature also reflects confusion over whether specialist and advanced practice are always the same or sometimes different. Advanced practice is frequently linked to specialisation throughout the literature. Although it is often interpreted as practice that is beyond the scope of a newly qualified individual, this can represent either working at a higher or broader level in general practice or having developed knowledge in a specialised field (Price, Edwards and Hazel, 2008). This is echoed by White and McKay (2004), who state that 'advanced practitioners work at higher levels of practice, beyond that associated with routine radiographic practice, and have developed knowledge and expertise in a specific field' (p. 218). The nursing literature also reflects the view that advanced and specialist practice are similar. Footner (1998) argues that advanced and specialist nurse practice is always characterised by further educational studies at an advanced level and is related to

working in the specialty field. The International Council of Nurses (2015) proposes that, 'the nurse specialist is a nurse prepared beyond the level of a nurse generalist and authorised to practice as a specialist with advanced expertise in a branch of the nursing field' (p. 12). These publications do not distinguish between advanced and specialist practice, but others interpret advanced practice as that which involves greater accountability and autonomy rather than expertise in a specialised field. The advanced radiographer is identified as someone who can take on leadership responsibilities and work autonomously (Hardy and Snaith, 2006). This view is supported by Read (2003), who indicates that advanced practice is much more strongly related to a high level of clinical decision-making than to undertaking very technical procedures.

It is, however, possible to find references to specialism as being different from, rather than an advancement of, general practice. Ferris (2009) and White and McKay (2004) use the term *different* in relation to specialist practice. Ferris (2009) refers to specialisation as emphasising difference and relating to practice that is exclusive or exceptional, and she clearly links specialism to new technologies, such as MRI. Cattini and Knowles (1999) define a specialist as a different level of practitioner. Hardy and Snaith (2006) also recognise this distinction, asserting that many radiographers who attain senior positions because of their technical skill in specialist imaging modalities are not necessarily advanced practitioners. Similar references can be found in nursing and other allied professions. Castledine (2004) says that the view held by many nurse educationalists, which is that the knowledge and skill required to nurse within some medical specialties is more complicated and difficult to attain than those required in others, is a myth. Smoyak (1976) emphasises the importance of realising that some nurses might learn to do different things from other nurses and that this should be reflected by educational curricula.

It seems, therefore, that the literature cannot provide any conclusive evidence for how best to define specialism. Table 2.1. (p.30) summarises the literature and their main arguments in support of specialism meaning advancement or difference in practice. There appears to be no universal language relating to specialist practice and there is a disparity of views on whether it is the same as, or different from, advanced practice. It appears that specialism can mean either difference of practice (unusual) or advancement of practice (unusually superior), depending on how the term specialist is interpreted. The proposition on which this research is based is that specialist imaging practice can sometimes be different from general

radiography, and there is some evidence in the literature that supports this concept (see Table 2.1). However, there is a conspicuous lack of consensus and most researchers seem not to have considered other routes to specialisation. In the absence of a clear rationale emerging from the literature on how best to define specialist practice, the stance that I have chosen to take is that in the context of MRI, knowledge and practice refers to working exclusively in MRI, rather than functioning at a high level of autonomy or complexity; in particular, when a practitioner first enters practice. This is based on the perspective that the knowledge required by an MRI practitioner is unusual rather than unusually superior, and that this knowledge is congruent with the skills and competencies required of an MRI practitioner practising at a basic level (Skills for Health, 2008) (see Table 1.1., p.11).

**Table 2.1. Summary of arguments advancement vs difference of knowledge**

	Publication	Argument
<b>Specialism is advancement</b>	Footner, (1998)	Advanced and specialist nurse practice is always characterised by further educational studies at an advanced level and is related to working in the specialty field.
	Read, (2003),	Advanced practice is much more strongly related to a high level of clinical decision-making than to undertaking very technical procedures.
	International Council of Nurses, (2015)	The nurse specialist is a nurse prepared beyond the level of a nurse generalist.
<b>Specialism is difference</b>	Ferris, (2009)	Specialisation emphasises difference.
	Cattini, Knowles, (1999)	A specialist as a different level of practitioner.
	Castledine (2004)	Knowledge and skill required to nurse within some medical specialties is not more complicated and difficult to attain than those required in others.
	Smoyak, (1976)	Nurses might learn to do different things from other nurses and that this should be reflected by educational curricula.
	Hardy, Snaith, (2006)	Many radiographers who attain senior positions because of their technical skill in specialist imaging modalities are not necessarily advanced practitioners.
<b>Specialism is advancement or difference</b>	White, McKay, (2004)	Specialism is working at higher levels of practice, beyond that associated with routine radiographic practice, and have developed knowledge and expertise in a specific field.
	CHCRE, (2009)	Specialism is working at a level beyond that of general practice or working in a specific area of practice.
	Price, Edwards, Hazel, (2008)	Specialism is working at a higher or broader level in general practice or having developed knowledge in a specialised field.

## 2.3. PROFESSIONAL ASPECTS OF SPECIALIST PRACTICE

I now explore different publications on the professional aspects of specialist practice. The purpose is to examine the themes that relate to the professional impact that early specialisation might have on the radiographic profession. Some of the literature is drawn from medical and nursing research, but the main emphasis is on specialist practice in radiography. The literature across all healthcare professions highlights potential barriers to, and benefits of, specialisation. These are summarised nicely by Ferris (2009), who states that ‘specialism is complex, divisive, and influential with dynamic and reactive characteristics that are linked to an increase in remuneration promoting status and recognition’ (p. e79). Specialist practice has increased across all healthcare professions. This is attributed to the increased complexity of healthcare and the introduction of new technologies. There have also been pressures from professional bodies and HEIs due to the development of knowledge and the need for research (White and McKay, 2004).

Most radiographers are recognised as specialists when they become skilled in a particular area, and this is likely to have a technical focus (Nightingale and Hogg, 2003; Hardy and Snaith, 2006). However, Ferris’ (2009) discourse suggests that the genesis of specialism in radiography is unknown and confirms that little is still understood about radiographers’ experiences of specialisation. Although she emphasises the confusion that exists about how best to establish the boundaries of specialist practice in radiography, her research also reveals a consensus on the common characteristics of specialism. These include ‘full time commitment, the capacity of a subject to divide, practice that was challenging and gave the radiographer clinical autonomy, and a need for additional training and education’ (p. e80).

As Section 2.4. explains, there is an ongoing debate on the advantages and disadvantages of specialist and generalist practice in healthcare. The literature includes voices that support and oppose specialisation. Specialism is seen to attract acclaim, prominence and esteem (Independent Commission for the Royal College of General Practitioners, 2011) and specialists enjoy improved job satisfaction as a result of acquiring specialist knowledge and skills (White and McKay, 2004). Patients benefit from the specialist’s knowledge, their ability to think critically and their ability to follow evidence-based guidelines (Footner, 1998;

Palmer, Naccarella and Gunn, 2007). This leads to increased trust and confidence in the care provided by a specialist (CHCRE, 2009). In addition, according to the National Health Service England (NHSE), specialists are able to focus on a discrete area of practice and gain a great deal of experience in their specialism, leading to a standardisation of care (2014). In radiography, specialism is commonly linked to new technologies but it is also characterised by clinical autonomy and increased professional status and recognition (Ferris, 2009). Specialism is a powerful contributor to building an individual's confidence and status, which has a positive impact on job satisfaction and staff retention (Ferris, 2009). Specialist radiographers are respected as valuable assets for patients, the profession, the radiology department and the practitioner themselves (Nightingale and Hogg, 2003; Lundvall, Dahlgrenb and Wirell, 2014).

So far, these publications reflect specialisation with reference to advanced practice, rather than an area of different practice. In midwifery, non-nurse midwives are those who enter practice directly rather than through the discipline of nursing. Davis-Floyd (1999) reports that although there is some resistance to early specialisation from nurse midwives based on unsubstantiated claims of unsafe practice, factual evidence demonstrates that direct-entry midwives consistently provide high-quality care. He also asserts that nurse midwives' opinions are shaped by their exposure to non-nurse midwives. Those who have had no exposure are more likely to form stereotypical opinions about the competency of non-nurse midwives, whereas those who work alongside them are fully supportive. Another reported advantage of early specialisation in midwifery is a reduction in healthcare costs (Stover, 2011).

The voices against specialisation warn of limitations in the scope of practice (White and McKay, 2004), fragmentation and competition between different areas of practice (Martin, Currie and Finn, 2009) and an over-preoccupation with specialisation at the expense of general practice (Castledine, 2004). There are also reported problems associated with accountability, responsibility, competence and regulation (White and McKay, 2004; Stover, 2011). The downside of exclusivity in radiographic specialist practice is emphasised in Ferris (2009), where it is seen to detract from patient-centred service provision. Ferris also claims that specialism does not always lead to better career progression, citing limited scope of practice as a major contributory factor. This important barrier to early specialisation is mirrored in other places in the literature, where claims are made that practitioners

who have skills in more than one imaging modality are more marketable and have the best employment opportunities (White and McKay, 2004; Weening, 2012).

In nursing and midwifery, academics are seen to have been influential in the way in which specialism has been viewed. Academics have also been a major force in the professionalisation of these practice areas. The linking of expertise with professional recognition has led to the introduction of non-core subjects, such as administration, management and finance, into undergraduate curricula (Footner, 1998; Akimito, Caruana and Shimosegawa, 2009). In addition, the resistance of some academics to the introduction of a separate profession is reported in midwifery. Naachi et al. (2010) state that some influential opinion-shapers from HEIs are continuing to ignore evidence that clearly shows the benefits of direct-entry midwives; instead, they are promoting the traditional points of view. In some countries, such as Brazil, this has influenced government policy and resulted in a lack of support for change (Naachi et al., 2010). This theme, and the others explored in relation to specialist practice, are central to my research, because they highlight the potential political and professional barriers to introducing direct entry into MRI practice. It is also evident that it is important not to isolate specialist practice but, rather, to view it from the wider perspective of how it compares with multi-competency. Therefore, an exploration of specialism versus general practice is necessary to ensure that my research can capture a variety of perspectives on specialisation.



## 2.4. THE SPECIALIST VERSUS GENERALIST DEBATE

My research raises important questions about specialist and generalist practice and which is best for service users and healthcare professionals. The literature reflects an ongoing debate about how each type of practice is defined and what type of practitioner is required for healthcare systems in the future. At the centre of the specialist versus generalist debate are the following questions: is it better to design a system where staff have highly specialised skills and are experts in a discrete area of practice or where they have broader skills but perform these in less depth? Are both types of practitioner needed and, if so, what is the right balance between a specialist and a generalist orientation of the workforce?

The division between generalist and specialist practice has existed for a long time. The Greek historian Herodotus reports on a 'plan of separation' where physicians consistently focus on patients with a single disorder (Palmer, Naccarella and Gunn, 2007). As knowledge developed, medical specialism gradually evolved and groups of practitioners merged. Apothecaries, physicians and barber surgeons were essentially generalists who specialised in a particular field of medical knowledge. The desire to become an expert in a defined area of practice, and the prestige associated with expertise, led physicians and then surgeons to become specialised in diseases or parts of the body. An increasingly clear division has emerged between general practitioners and hospital specialists, and this culture of expanding specialisation has proliferated into the allied professions. Specialist, advanced and consultant roles in radiography, physiotherapy and nursing, where practitioners work in a discrete area of practice, are well established (Stover, 2011). However, the separation of generalist and specialist practice has always been contentious. 'The first essential is to curb the incentive for specialisation, which has been encouraged to an unreasonable degree' (Stover, 2011, p. 395).

The distinction between general practice and specialism is traditionally framed in terms of scope of practice. Specialism refers to depth of expertise, whereas general practice is related to breadth (Independent Commission for the Royal College of General Practitioners, 2011). Generalism is associated with practice that is universal; it refers to treating all patients or investigating diseases of all kinds. A generalist, therefore, is a person who is competent in several different areas of practice (Castledine, 2004). By contrast, the advantages of a specialist, who has in-

depth knowledge and skills in a narrow area of practice, seem intuitively beneficial. However, it is argued that too great a focus on specialisation encourages healthcare professionals to look at the parts rather than the whole, and this can result in a less person-centred approach to the delivery of care. It can also lead to the medicalisation of complex problems and to increased risks associated with greater interventions (Palmer, Naccarella and Gunn, 2007).

Generalists and specialists have always faced conflicts in competing for patient loyalties and professional prestige (Pearson, 1999). Recent changes in policy that emphasise the importance of primary care have raised the profile of general medical practice, but the development of new technologies has altered the character of the medical profession and its internal differentiation. Freidson (1984) notes the emergence of a knowledge elite; this is echoed by Harrison and Ahmad (2000) in their description of the rise of scientific bureaucratic medicine, where new technologies contribute to stratification within the profession. This fragmentation leads to competition, where power over knowledge and jurisdiction is retained by specialists (Martin, Currie and Finn, 2009).

There are ongoing debates in the medical literature as to whether it is possible to measure the health outcomes of generalist or specialist care and which approach is more beneficial to patients (Palmer, Naccarella and Gunn, 2007). Research looking at the outcomes of patients in specialties, such as cardiology, reveals that patients who are treated by specialists have lower mortality rates and recover faster than patients who are treated by generalists (Moore and Duncan, 1997). In the *NHS Five Year Forward View* (NHSE, 2014), the National Health Service (NHS) national leadership sets out its vision for the future and emphasises the need for a more holistic, patient-centred approach to care. They stress the importance of breaking down the traditional artificial barriers between primary and hospital care and between specialists and generalists. They advocate delivering care that is organised around patient-centric models, citing examples of models of healthcare that link patient-focused healthcare to improved outcomes. However, specialism is still valued and there is recognition of a strong relationship between access to specialised facilities and their staff and standardisation of care. The reduction in variations in the quality and safety of care is seen as a driving force in the need for change (NHSE, 2014). A commonly held view is that the strength of the generalist lies in their ability to provide continuity of care and to take a view of the patient as a whole person, rather than as a presenting illness. However, this is a narrow

perspective, as patient-centric care is not an attribute that is peculiar to generalists. A specialist can also practise holistically; in particular, in specialties that are characterised by long-term contact with patients (NHSE, 2014). The Independent Commission for the Royal College of General Practitioners (2011) advocates the use of the term *comprehensiveness* as a core quality of the generalist, but recognises that this has its own limitations.

One criticism levelled at the generalist approach is that as healthcare becomes more complex, generalists inevitably know less about everything; therefore, there is a danger that a point will be reached where generalists know so little that they become less effective at delivering world-class patient care (Palmer, Naccarella and Gunn, 2007). This concern is relevant across the allied professions, including radiography. Radiographers are required to operate competently across a variety of different imaging modalities and, consequently, undergraduate curricula are becoming increasingly overcrowded (Payne and Nixon, 2001; Hardy et al., 2008). The danger is that imaging graduates know increasingly less about each area of practice and their level of expertise declines. Despite this, many radiographers perceive that expert practice is related not only to how well they acquire images but also to their ability to accept referrals, interpret the images and discuss their findings with clinical colleagues (Ferris, 2009).

Clearly, there are tensions between how expertise is defined in terms of competence in an area of practice and how it is interpreted in terms of a comprehensive approach to patient care. Despite policy that emphasises the need for a holistic rather than specialist approach to healthcare, Coulter's study of the NHS suggests that patients care more about the quality of their everyday interactions with health professionals than about how the service is organised (Coulter, 2005). It seems, therefore, that what patients want is staff who have good interpersonal and communication skills and provide safe and flexible healthcare, irrespective of where they are positioned on the generalist–specialist spectrum (Coulter, 2005).

In the healthcare professions there are also many voices that oppose specialism, citing problems such as the limited scope of practice of specialists in terms of departmental workflow, employability and marketability. Castledine (2004) warns of nurse specialists ending up in a medical 'cul-de-sac' and argues that nurses should be specialising in the holistic needs of the patient rather than a specific disease.

These sentiments are echoed in mental-health nursing, where research suggests that specialism in this area of practice has a negative impact on employment opportunities and work-related stress due to professional isolation (Lloyd, King and Bassett, 2002). Ferris (2009) found that perceptions of specialism in radiography originate in exclusive and restricted practice. This separateness is exacerbated by physical boundaries imposed by radiation and magnetic fields. White and McKay (2004) also warn against specialisation creating fragmentation of the profession. This is a valid counter-argument to early specialisation. In cost-conscious healthcare environments, generalist practitioners are perceived to be more employable than those who can work in only one discrete area of practice. Terrell-Nance and Thomas (1995) and the Pew Health Professions Commission (1992) emphasise the fact that employers see multi-competency as essential. This is supported by Rosser (2015), who sees flexibility as a necessary skill for practitioners in healthcare delivery in the future. This is an important consideration for my research, as there would be little point in educating practitioners in a discrete area of practice if their limited scope of practice negatively affected their employability.

Traditionally, specialism is viewed as being more prestigious than generalist practice by patients and healthcare professionals. This culture has reinforced the traditional boundaries that the NHSE (2014) is so keen to break down. Many nurses see specialisation as a way of enhancing their reputation and status (Castledine, 2004). The International Council of Nurses (2015) argues that specialisation is a process that has deepened and refined nursing practice. This is reflected in other professions, such as occupational therapy and physiotherapy, where specialist roles have raised the profile of these professions (Lloyd and Williams, 2009). Specialism has developed awareness amongst other healthcare professionals, and this recognition has supported collaboration rather than separation (Parker, 2001; Fox, 2013).

In their review of the literature on specialism, White and McKay (2004) cite several articles that demonstrate that radiographers are extending their roles successfully and competently. They remind us that this fits well with the multi-disciplinary approach to healthcare, where expertise and professional recognition from others in the team is important. This argument is echoed in Ferris' (2009) study, where statements include how specialism enables clinical autonomy and career progression. Scott (1998) emphasises the need for specialisation in nursing

practice to meet the changing complexity of, and technological advancements in, healthcare. This has resonance in radiography, where practitioners need to keep pace with huge technological developments in modalities such as MRI.

One of the key points made by NHS leadership is that there is a need for a new model of healthcare that supports patients with multiple health conditions rather than single diseases (NHSE, 2014). This is in response to the fact that the UK's ageing population is already having a profound effect on the way in which healthcare is delivered, and this is likely to increase in the future. In the UK, the majority of hospital beds are occupied by patients over 60 years of age. Six in 10 older people are living with at least one long-term condition, and many have two or more (NHSE, 2014). The ageing population is having an impact on the provision of MRI services and, therefore, on MRI practitioners and their patients. The continuous emergence of new technology to diagnose and treat disease means that many people are living with conditions that previously would have been fatal. The escalation of patients with multi-system diseases and the expansion of the capabilities of MRI and other imaging modalities to diagnose these diseases means that the demand for these services has increased exponentially. In 2010, the Organisation for Economic Co-operation and Development (OECD) estimated that there were nearly 20,000 MRI scanners worldwide. However, this excludes certain countries, the private sector and non-hospital-based MRI scanners in many instances (OECD, 2010). In surveys carried out more recently, the OECD reports on the number of scanners per million of population; according to the latest survey, the number of MRI scanners per million of population increased between four- and eight-fold between 2007 and 2011 in most developed countries (OECD, 2013).

Therefore, looking forward, the specialist versus generalist debate will have a significant impact on developing the optimum workforce in an imaging department. If more patients are presenting with multiple conditions, are they best served by imaging professionals who can use all types of imaging equipment and follow them on their diagnostic pathway? Alternatively, are they better served by different practitioners who are experts in a specific imaging modality? Which option is the best in terms of patient care and safety? These questions have important implications for educating specialists and generalists in the future. However, it is also clear that there are professional and cultural perspectives on the debate. One consideration is that the complexity of MRI scanners has increased significantly as manufacturers squeeze proprietary features into new systems. However, as most

imaging practitioners are multi-competent radiographers who are not fully educated in the complexities of MRI, they tend to use very few of the features that are designed to enable the most efficient scanning protocols (Westbrook and Talbot, 2009). Even more concerning is that there can be catastrophic outcomes of not using the equipment correctly or safely. This concluding point is important. Although the strengths of generalist and specialist practice are explicit, and healthcare professionals in both domains need to find models to collaborate more effectively, patient safety must be a priority. The provision of educational curricula that produce the most competent and safe practitioners should, therefore, supersede all other considerations. Therefore, the educational aspects of the research problem are evaluated in the following section.

## 2.5. EDUCATING THE SPECIALIST

In this section, the literature is used to explore the ways in which healthcare specialists are educated. The purpose is to provide background to this research and justify my research idea. The literature is mainly drawn from nursing practice, where there is a relatively long history of clinical nurse specialist practice in addition to direct entry into a specialism. Literature from other allied professions, such as radiography, occupational therapy and midwifery, are also referenced. Literature that refers specifically to MRI education is limited, but is included to contextualise this theme within MRI.

The purpose of a healthcare educational programme is to ensure that students gain sufficient knowledge and skills to practise at a competent and safe level.

Knowledge is understood as the facts or experiences known by a person (SCoR, 2010). A general definition of competency might be that it requires the acquisition of knowledge that enables an individual to perform with ability and efficiency (Footner, 1998; Delamare-Le Deist and Winterton, 2005). The Bologna Working Group in Europe suggests that competence relates to cognitive use of theory and concepts, functional competence in skills required in a particular role, and personal and ethical competencies relating to conduct and values (Bologna Working Group, 2005; Castillo, Caruana and Wainwright, 2011).

In nearly all of the literature, post-qualification education is seen as a clear indication of specialism. The majority points to an assumption that specialism always involves role extension or expansion. Many authors support the notion that an individual cannot be deemed a specialist until they have successfully completed further educational studies that build upon their general education (Footner, 1998; Price, Edwards and Hazel, 2008; International Council of Nurses, 2015; Rosser, 2015). White and McKay (2004) go so far as to say that academic acclaim is a requisite of specialist practice. However, these assumptions appear to be based on the concept that specialism is always related to advanced practice, where high levels of practice are expected. For example, according to Jones and Bale (1994), nurse specialists need to display advanced analytical skills, engage in autonomous decision-making, display high cognitive levels and have well-developed leadership and communication skills. These behaviours are naturally associated with education at a master's or doctoral level (Rees, 2004).

In nursing, radiography and some of the other allied professions, most practitioners functioning at an advanced level are required to have a postgraduate qualification (White and McKay, 2004; Ford, 2010). From 2010, the nursing and radiography professional bodies advised that all advanced practitioners undertake doctoral or master's level studies. However, McSherry and Johnson (2005) and Ford (2010) assert that attrition rates amongst nursing appointees with master's and doctoral qualifications are higher than those with only a postgraduate certificate. Therefore, they speculate that academic prowess may not necessarily result in retention of specialist staff (McSherry and Johnson, 2005; Ford, 2010).

Another problem is that postgraduate curricula may not always provide the specialist with the skills they require. The emphasis of many postgraduate curricula is on a constructivist model, which directs study towards the achievement of the clearly defined learning outcomes that are embedded in the higher levels of Bloom's taxonomy (Anderson and Dron, 2011). Tobias (2010) emphasises the fact that if constructivism is to be effective, learners must have prior knowledge on which to construct their own meaning. Because specialist imaging modalities, such as MRI, are not taught in depth at undergraduate level and experiential learning is patchy and problematic (Castillo et al., 2016), postgraduate students may not always have the necessary underpinning knowledge to enable the achievement of high-level learning outcomes. The hallmarks of mastery are independent and autonomous practice based on the ability to analyse, evaluate and create new thinking, but many postgraduate programmes struggle to design curricula that produce students who have acquired these skills (Khan and Pakkal, 2002). Student-focused learning that emphasises the acquisition of critical-thinking skills and the application of these to real-life settings often present a challenge to academics (Pew, 2007). Marshall (2008) advocates that educators are responsible for helping students to develop mastery skills by embedding these skills into, rather than isolating them from, module content. She takes a less reductive learner-focused approach. She has developed several teaching and learning initiatives to promote the idea that learning how to learn is as important as what is being learned. Although Marshall reports success with these strategies at her institution (Marshall, 2008), it is not clear how other HEIs fare in this respect.

There is a paucity of literature exploring experiential or other types of learning in specialisms, and there is very little on whether specialism can be learned at



undergraduate level. The nursing literature appears to be more eloquent than that of other professions on this subject. Some references warn against undergraduate curricula that focus too narrowly on specialist knowledge before the fundamental underpinning principles are understood (Fetters, Curry and Creswell, 2013). However, others advise against programmes that focus entirely on generalist knowledge, as this can either inhibit further professional development or result in practitioners working beyond their competency in specialist practice, with sub-optimal outcomes for patients (Hannigan and Allen, 2011).

Specialisation at undergraduate level is, however, permitted in some healthcare professions. In 2000, nursing in the UK moved from having one generalist point of registration to four discrete areas of practice. Consequently, after completing a common foundation programme, nurses can register to practise in the following specialisms: adults; children and young people; learning disability; or mental health (Rosser, 2015). However, potential pitfalls are associated with this model. One problematic area is how nurses who are registered in one area of practice can transfer their skills. Nurses are expected to be flexible, especially as the delivery of health and social care services is being transformed to reflect a holistic, patient-centric system that is able to care for patients with multiple diseases (NHSE, 2014). With this in mind, Ham, Dixon and Brooke (2012) advocate the need for undergraduate curricula that reflect both generalist and specialist knowledge. Nursing undergraduate curricula were reviewed by the Willis Commission in 2012; this review recommended that specialist education be brought into the third year of study, following two years of generalist foundation knowledge (Willis Commission, 2012). This, however, raises further questions about how specialism is successfully integrated into the curriculum. For example, how is foundation knowledge defined? How would general theory be applied to each specialism? Is the development of specialist knowledge during preceptorship the responsibility of education or practice? It is also not clear how the introduction of a foundation of generalist knowledge followed by a further preceptorship in a speciality would affect current clinical nurse specialists, especially if graduates were to leave with the same specialist award and title (Rosser, 2015).

Direct entry into midwifery without the need to first qualify as a general nurse is another example of how specialist practice is not always associated with post-basic education. Increasing birth rates required an increase in the midwifery workforce (World Health Organization, 2004). This stimulated the introduction of curricula that

enables direct entry via an undergraduate degree as an alternative to post-qualification midwifery training for nurses (World Health Organization, 2004). Professional conflicts were anticipated, especially when both types of practitioners worked alongside each other. However, there is evidence that nurse midwives respect the knowledge of their non-nurse midwife colleagues and that non-nurse midwives often out-perform them (Davis-Floyd, 1999). Stover (2011) cites research that compared the academic performance of both types of practitioner and found that there is no difference between them. In the clinical setting, where nurse-midwives might have been expected to have an advantage because of their prior training, direct-entry and nurse-midwives demonstrated similar skills. The authors concluded that although there were variations in training, direct-entry midwives are highly educated and clinically competent (Stover (2011)).

Overall, there is some evidence that supports the idea that specialism could be taught at undergraduate level, although the overwhelming majority assumes that only post-basic learning is appropriate. This assumption does not, however, appear to be grounded in evidence or well-described theory. It is clear that my research will need to address these gaps.

### 2.5.1. Radiography education

The SCoR defines a diagnostic radiographer as someone who ‘employs a range of different imaging techniques and sophisticated equipment to produce high-quality images of an injury or disease’ (2013a, p. 9). According to this definition, diagnostic radiographers are multi-competent practitioners who are trained to use a range of different imaging techniques. MRI and other radiographic modalities, such as ultrasound, angiography, nuclear medicine and CT, are usually termed *specialist modalities*. This is because historically, they are techniques that are used beyond the scope of general radiographic practice; therefore, radiographers naturally progress into them post-qualification.

There are disagreements as to whether practice in specialist imaging modalities should continue to lie wholly or partly within the practice remit of radiographers (Cowling, 2013). There is also a general lack of standardisation of radiographic educational provision. The 2012 survey of European radiography education by the European Federation of Radiographer Societies (EFRS) found that most pre-registration education is delivered at bachelor’s level but there is a huge variation in

content and course duration. In addition, some programmes permit graduates to qualify in single or multiple areas of competency (McNulty et al., 2016).

Consequently, there are inconsistencies in the accepted scope of practice of a radiographer and there are variations in the breadth and depth of education to support the radiographer role. This lack of consensus has impeded a unified understanding of what should constitute standard radiographic practice and how specialism should be taught (Hardy et al., 2008).

Radiography became a recognised profession in the UK with the foundation of the Society of Radiographers in 1920 and later the College of Radiographers (COR), which oversaw the education and research interests of the profession. Over the coming decades, the education of UK radiographers evolved from an apprenticeship to a COR diploma. After a professional and political debate that spanned nearly two decades, the COR relinquished its control of education to HEIs and radiography became a graduate profession in 1993 (Price, 2009). In 2002, the Department of Health and SCoR, in consultation with radiographer managers, developed a new working framework for radiography. The resulting *Radiography Skills Mix* paper (Department of Health, 2003) concluded that it was necessary for radiographers to extend and expand their roles to support changes in NHS service delivery. This coincided with the *Agenda for Change* (Department of Health, 2004), which brought in a new banding system for radiographers based on professional knowledge and expertise. Consequently, a four-tier multi-disciplinary system was introduced, which consisted of assistant, standard, advanced and consultant practitioners or radiographers. The premise was that after formal training, assistant practitioners could undertake some of the routine roles of standard practitioners. This would, in turn, free practitioners to move their roles into more advanced areas of practice after studying at postgraduate level. The creation of a new consultant grade was intended to enable practitioners to work alongside medical staff in leadership roles and encourage doctoral study (Department of Health, 2004). The HEIs responded by validating a range of programmes at varying academic levels to match each tier in the multi-disciplinary model. Foundation awards were established to educate assistant practitioners in general radiography and in specialisms, such as MRI. At the other end of the spectrum, postgraduate courses were established to advance practice in radiography and to allow radiographers to acquire knowledge in specialisms, such as image reporting, MRI and ultrasound.

There is quite a lot of literature in radiography research on advanced- and consultant-level practice. However, much of this is historical, reflecting research into these levels of practice when they were first introduced. Although some authors suggest that extended role skills can be gained equally through experiential learning (Hardy and Snaith, 2006), it is widely argued that postgraduate educational curricula, from postgraduate certificate to doctoral level, are appropriate for the advanced and consultant tiers of practice. This is because these practitioners require additional leadership and communication skills for roles that come with increasing responsibility and accountability (Price, Edwards and Hazel, 2008; Ferris 2009; Ford, 2010). There is also a consensus that the clinical status of a radiographer performing at an advanced level is reinforced by academic qualifications. Some go so far as to say that anything less than a doctorate places consultant radiographers on an unequal footing with their medical consultant colleagues, despite the fact that most medical doctors are not educated to doctoral level (Manning and Bentley, 2003). Knowledge is seen as an integral part of advanced and consultant practice that enables role extension beyond that of basic practice. Ferris (2009) consistently links this type of practitioner with specialism and with postgraduate qualifications, but Caruana and Plasek (2006) suggest that although these roles should require a formal university-based qualification, this could be at either bachelor's or master's level depending on the level of entry qualification.

The rapid expansion in medical imaging technology has led to a transformation in the role of diagnostic radiographers. They not only perform conventional diagnostic X-ray procedures, such as barium studies and bone and chest radiography, but also specialise in certain areas, such as MRI and ultrasound. At undergraduate level, traditional curriculum content and teaching is mostly designed to provide only a broad overview of general radiographic principles (White and McKay, 2004). However, now that HEIs are freer to establish their own curricula, other models are emerging that attempt to capture generalist and specialist knowledge. These include curricula that are initially based on a wide scope of practice followed by a form of specialisation in a chosen imaging modality; and curricula where all the commonly used imaging modalities are introduced, followed by parallel development of student competence in all modalities (Caruana and Plasek, 2006). Akimito, Caruana and Shimosegawa (2009) assert that in some HEIs, traditional general subjects are given less importance than specialised subjects, and they

claim that this is adversely affecting student achievement in general and specialist knowledge.

Clearly, the broad scope of radiographic professional competencies and an additive, rather than an evolving, philosophy has led to a very overcrowded radiographic undergraduate curriculum that provides limited scope for learning in specialist areas (Price, High and Miller, 1997; Pratt and Adams, 2003; Lombardo, 2006). Williams and Berry (2000) used the consensus-building Delphi technique to establish a range of competencies for newly qualified diagnostic radiographers. A nationwide consortium of academics and clinicians identified nine broad competency categories, ranging from technical knowledge and clinical competency to administrative responsibilities, communication skills and research skills. To ensure that these competencies are met, curricula must include a plethora of general and specialist imaging techniques and facilitate new skills, such as research methods and enquiry-based practice. In a blended study of 39 recently qualified radiographers and their workplace supervisors, Mackay, Anderson and Hogg (2008) investigated whether graduates had attained a range of competencies based on those identified by Williams and Berry (2000). The findings suggest that, for the most part, the competencies have been achieved, but most graduates have little competency in specialist practice (Mackay, Anderson and Hogg, 2008).

Another problem is the tendency for undergraduate curricula to orientate towards the image-reporting and healthcare-management aspects of radiography. Akimoto, Caruana and Shimosegawa (2009) claim that this has occurred at the expense of the technological aspects of radiography and as a consequence of restricted curriculum time. If true, this might limit the number of practitioners who can specialise in imaging modalities, such as MRI, which rely heavily on a deep understanding of physical and technical principles. This point is reinforced by Cowling (2013), who reports that there is an increasing demand for practitioners who are technically proficient in the newer modalities but there is a commensurate lack of provision for this knowledge in undergraduate radiographic curricula.

Learning a specialism after professional qualification at degree or diploma level is firmly rooted in healthcare education. There is little evidence to suggest that researchers have considered the possibility that radiographic specialism could be taught via a dedicated undergraduate degree. Most of the literature that might tentatively support this idea is directed at highlighting the problems of how to

deliver specialist education post-registration, rather than advocating a positive change of action. Hardy and Snaith (2006) are the most vocal, insisting that formal education and additional post-registration qualifications are not essential components of specialist practice. They also claim that postgraduate programmes do not necessarily provide practitioners with the skills required for specialist practice. More practical concerns can also be heard. Increasing student debt and the need for radiographers to earn an income rather than take time off to further their studies act as disincentives to engagement in postgraduate study in a specialist imaging modality (Lombardo, 2006).

Therefore, there appears to be a lack of cohesiveness in terms of whether – and how – specialism can be taught at undergraduate level. The hierarchical constructs of Bloom and Benner are commonly used to align the content of an educational programme with its outcomes, and these constructs provide a useful framework for determining the level of education that best suits the specialist (see Chapter 3). These two constructs, both with five levels placed in a hierarchy, provide a useful framework for curriculum planners to ensure that learning outcomes align with course content and level. Benner and Bloom are referenced by White and McKay (2004), Caruana and Plasek (2006) and Hardy and Snaith (2006) in attempts to align the practice of different levels of radiographer with levels of knowledge and skill. Caruana and Plasek (2006) assert that the competencies of an entry-level radiographer include the safe use of medical imaging equipment under protocol and with limited supervision. A full range of practice at entry-level is possible, including some complex situations, and the necessary cognitive processes are mainly application and analysis. Hardy and Snaith (2006) agree that a new graduate practitioner should be able to undertake a wide range of simple and complex imaging examinations on the full range of patient types and conditions and in a variety of settings. HEIs are advised to include the psychological and sociological dimensions of caring for patients in addition to the technical aspects of radiography in their curricula (SCoR, 2013a). Caruana and Plasek (2006) and Hardy and Snaith (2006) assert that this level of competence aligns best with Benner's definition of a proficient performer and levels three and four of Bloom's taxonomy. However, White and McKay (2004) disagree. They believe that the skills required of a newly qualified radiographer best align with two levels below proficient (advanced beginner), and that only practitioners who have attained a higher level of specialty practice are proficient. Interestingly, none of these authors attempts to map entry-level MRI practice with Benner's competent and Bloom's first three

stages, which are acknowledged as those that best align with graduate knowledge and skills (Bloom et al., 1956; Anderson et al., 2001; Benner, 2004).

These articles refer to the generalist radiographer; therefore, it may be more appropriate to draw on literature that relates more closely to MRI practice. The Australian Sonographers Association (ASA) (2011) used Bloom and Benner to establish the competency standards for sonographers who perform ultrasound scans. This has relevance to my research because, like MRI, ultrasound is a specialist imaging modality that does not use damaging radiation. In Australia, direct entry into this discrete area of practice has been permitted without the need to first qualify as a radiographer, which provides a useful precedence on which to base my research. The ASA standards map the entry-level competencies of a graduate sonographer who has not previously qualified as a radiographer with the competent stage of Benner's model (level 3). In the UK, there are also moves to allow direct entry into ultrasound via the undergraduate route; however, as yet, there is no agreement on the scope or level of practice and there are no agreed competencies. According to the SCoR, there is, however, an expectation that newly qualified graduate sonographers will practise at the same banding level as newly qualified graduate radiographers (SCoR, 2013b). Therefore, one assumes that the competencies will need to align with those of the ASA. In the context of direct entry into ultrasound, there is a slowly developing consensus that a specialised undergraduate degree is feasible from an educational perspective (SCoR, 2013b). This might be transferable to other imaging specialisms, such as MRI.

### **2.5.2. MRI education**

MRI is a rapidly developing and leading imaging modality (Westbrook, 2014). New applications are constantly being introduced and patient numbers are increasing (Castillo et al., 2014). The energies used in MRI are not high enough to cause tissue damage, but the MRI scanner is a large electromagnetic, which produces a very strong magnetic field, and significant safety issues are associated with it. For example, metal objects inadvertently brought into the scan room travel at high speed towards the magnet and these have been known to cause death and serious injury (Castillo et al., 2014).

MRI practitioners are ultimately accountable for the safety of anyone, including staff, patients and relatives, entering the magnetic environment. In addition, MRI

practitioners must be able to apply theoretical knowledge effectively to a range of clinical situations (Skills for Health, 2008). Modern MRI systems have a very high degree of automation, but the technical complexity and versatility of MRI means that scanning protocols can be modified in a variety of ways to visualise pathology. In order to practise knowledgeably enough to do this, MRI practitioners must master a plethora of imaging parameters and have a deep knowledge and understanding of MRI physics.

Previous research suggests that the education of MRI practitioners is highly variable. Training is mainly experiential and is largely provided in-house by other MRI practitioners or via short demonstration sessions by applications specialists from equipment vendors (Castillo et al., 2016). There are some theory-based short courses, but these often involve the delivery of a large amount of knowledge to a large number of students in a short period. As a result, information is usually conveyed via a series of teacher-focused lectures, as this is seen by some as an efficient way of compressing knowledge into a short, deliverable package. These courses are usually informally delivered by individuals whose performance is not monitored, and students are rarely assessed (Westbrook and Talbot, 2009; Castillo et al., 2016). An assumption is often made that students can acquire knowledge and apply this later to their practice. Benner (2004) found that individuals learn most effectively when there is a continuous, reciprocal dialogue between the classroom and the clinical setting. However, as it is not usually feasible to have an MRI scanner on site during a short course, MRI practitioners cannot easily do this. In addition, high-quality courses are becoming increasingly expensive and practitioners often find it difficult to obtain study leave due to higher workloads (Castillo et al., 2016).

In the UK and in other countries where postgraduate education is available, any formal qualifications in MRI must be acquired through postgraduate study. These courses, however, are limited to a small number of countries and the system has several flaws. For example, in New Zealand it is currently compulsory to have a postgraduate qualification in MRI to practise, but some see this as inappropriate for the skills and competencies required of an entry-level MRI practitioner (Castillo et al., 2016). Young (2008) claims that after the introduction of mandatory postgraduate-level study in New Zealand there was a sense of being overqualified for the job. In the UK, there are currently seven postgraduate courses exclusively in MRI or in medical imaging where MRI is a significant component. Most of these



curricula include modules in applied science, routine and advanced practice and research. Students undertaking a postgraduate MRI course have usually only studied the basics of MRI at undergraduate level (Portainier, Castillo and Portelli, 2014). Therefore, they have to grasp the academic requirements of mastery at the same time as acquiring a significant amount of new knowledge. The QAA for Higher Education (2014) stipulates that when developing postgraduate curricula, academics should assume that prospective students have acquired background knowledge through study at bachelor's level. However, this is usually not the case in specialist imaging areas, such as MRI, which might be one of the reasons why students often find postgraduate MRI programmes challenging. In addition, due to high demands on the workforce and difficulties in obtaining study leave, many of these courses are delivered via open distance learning, which is an added challenge for students who are unfamiliar with this type of study (Portainier, Castillo and Portelli, 2014).

The European Parliament has attempted to standardise the development and delivery of radiographic curricula to enable individuals to transfer their skills easily across Europe (European Parliament Council, 2008). Although the SCoR has published an education and career framework to serve as a guideline for generic professional development (2008), it does not reference this standard or Benner's novice-to-expert continuum (Benner, 2004). In addition, the EFRS, which identifies MRI as a specialist field, has expressed the intention of developing a framework for MRI qualification and certification across Europe (2012) but, to date, nothing has been published.

A handful of HEIs in the USA have introduced undergraduate educational programmes, resulting in an associate or bachelor's degree in MRI, and non-radiographers are permitted to complete these courses. The curricula are based on objectives and competencies constructed by the American Registry of Radiologic Technologists (ARRT). Similar criteria are used in Canada, where specialised undergraduate programmes in MRI have also been established. Several years ago, the ARRT developed a certification examination in MRI, which is based on an objective structured clinical examination (OSCE) (ARRT, 2011), but there is no universal requirement to complete it. In some states, it is not possible to practise in MRI without successfully completing the examination, whilst in others this is not required.

The present variability of MRI education for practitioners before and after qualification and the policy vacuum in this area have led to levels of expertise that are so diverse that serious doubts have been raised about the effectiveness and safety of practice (Westbrook and Talbot, 2009). Concern has been expressed that current educational strategies are not fit for purpose (Westbrook and Talbot, 2009) and it is evident that there is a need for change.

## 2.6. THE CASE FOR NEW RESEARCH

To date, only two published studies have tested the knowledge of MRI practitioners. In 2007, I collaboratively conducted a quantitative study on behalf of the Department of Health (published in 2009), which objectively assessed the knowledge of 47 MRI radiographers who were registered to practise in the UK. Some of the participants had previously practised in the European Union and their MRI experience ranged from one to 15 years. Most were radiographers working in MRI practice full time, but some were working at a more advanced level; that is, in addition to practising in MRI, they also took on a leadership role. One of the participants taught MRI as an applications specialist. Data on the way in which MRI had been learned was not specifically collected. However, research that is more recent suggests that experiential learning is the commonest method (Castillo et al., 2016), so it is likely that this was also the case for participants in the 2009 study. We used an OSCE to assess a range of MRI topics referenced from a database of questions that had been developed to inform the ARRT's standardised MRI curriculum (ARRT, 2014). Our results showed that nearly 75% of the participants scored less than 50% in the OSCE and 42% did not know the essential MRI safety criteria. The interpretation of these results raised the possibility of flaws in the current provision of MRI education (Westbrook and Talbot, 2009.). The idea that underpins my research, which is that a solution may be to educate specialists initially and exclusively in MRI, sprang from this study.

The only other research that assesses the knowledge of MRI practitioners was conducted by Weening, Gilman and Greenidge (2012). This large retrospective study investigated the first-time failure rates of 11,484 ARRT MRI certification examination candidates during a five-year period with the aim of determining the risk factors for failing the examination. They compared the failure rates of practitioners who had learned MRI post-qualification (called post-primary candidates) with the failure rates of those who had learned MRI via an undergraduate degree programme (called primary candidates). The post-primary group had learned MRI in a variety of ways, including short courses and experiential learning. The primary group had all undertaken an undergraduate programme in MRI, but the data did not include information on whether they had first qualified as radiographers. The authors showed that the post-primary candidates had failure rates that were 1.6 times higher than those of the primary

candidates, advocating the potential advantages of formal professional educational programmes.

A consensus report on the future of MRI education in the USA, which was completed after a survey of 42 MRI education programme directors, from 25 MRI education programmes makes several recommendations (Weening, 2012). The report claims that MRI requires a completely different didactic and clinical education from that of radiography and that MRI should be recognised as separate. The report calls on the ARRT to recognise that being registered in radiography is irrelevant for MRI practitioners, and states that MRI job descriptions should not require knowledge of radiography. This report is revealing and addresses apparent criticisms of direct-entry educational programmes. One respondent claimed that the notion that completing a radiography degree provides vital experience of patient care and is required as a rite of passage to become an MRI practitioner does not hold up in the clinical setting. Another asserted that many students complete a radiography degree simply to be able to move into MRI practice. Consequently, two years are spent training students in radiographic skills that they do not put into practice post-qualification (Weening, 2012).

The sentiments of the need for change are echoed by others. The increasing variety and complexity of imaging equipment has gone hand in hand with rapid advances in healthcare technology. Caruana and Plasek (2006) warn that physics and technology education has not kept pace, leading to under-utilisation of imaging devices and an increase in the number of instances of incorrect use. MRI practitioners now require a wider range of skills and knowledge, including a greater understanding and application of knowledge of anatomy, pathology, physics and technology. Consequently, the education of MRI practitioners requires substantially more than just training in skills related to MRI (Young, 2008).

These studies of Westbrook and Talbot (2009) and Weening, Gilman and Greenidge (2012) sit close to my research. Both assessed the OSCE scores of MRI practitioners and both identified differences in knowledge between two groups of practitioners. However, Weening, Gilman and Greenidge (2012) did not directly test the knowledge of their participants. Their study retrospectively analysed examination scores and used these to measure first-time failure rates. Consequently, their findings make only indirect inferences about the knowledge of their participants. In addition, neither of these studies differentiated between

radiographers' and non-radiographers' knowledge of MRI. Westbrook and Talbot (2009) collected data from only MRI practitioners who had first qualified as radiographers and did not correlate OSCE scores with the ways in which MRI had been learned. Weening, Gilman and Greenidge (2012) did not differentiate between those who were and were not radiographers in the primary group, and the authors admit that it was not possible to extract this information retrospectively from the raw data of the ARRT examination scores. Therefore, it was not possible for either study to ascertain the impact of direct entry into MRI practice without first qualifying as a radiographer.

Failure rates in Weening, Gilman and Greenidge's (2012) study are presumed to reflect revised and memorised knowledge, rather than working knowledge as applied to practice. This is because the ARRT examination is based on a standardised curriculum that candidates are advised to learn, revise and memorise beforehand. Therefore, the knowledge that was tested might have been recently acquired rather than reflecting participants' working knowledge on the day of the test. Finally, neither research study accounted for the possibility that participants might have answered a question correctly by chance. This is important, because the OSCE format used in both studies is an assessment that is based on a multiple-choice system, where participants can guess the answer (Weening, Gilman and Greenidge, 2012).

There is, therefore, a clear need for further research that specifically bridges the gaps in these studies and investigates a new approach to MRI practitioner education.

## 2.7. CONCLUSION

The review of the literature confirms the relative lack of research in specialist education and practice, especially in radiography. There are only two published papers that test the knowledge of MRI practitioners, neither of which differentiates between radiographers and non-radiographers who practise MRI or explores the professional implications of direct entry. Most of the literature on educating specialists assumes that specialism represents an advancement of prior knowledge and, therefore, that it is best learned at postgraduate level. Specialism is consistently linked to increasingly complex skills and behaviour acquired post-qualification. There is confusion about how best to define specialism, especially in radiography, and there is a lack of consensus on how this can be consistently and credibly differentiated from advanced practice. Most of the research relating to direct entry refers to midwifery, which, in general, paints early specialisation in a good light. However, the nursing and medical literature highlights some important problems that are associated with specialist practice, including limited scope of practice and professional fragmentation and competition.

This chapter has enabled me to understand clearly what has been published on the topics that frame my research and conceptualise what this study needs to address. Firstly, to explore how best to educate MRI practitioners it is necessary to assess the knowledge of clearly identified groups who learn MRI in different ways and, consequently, explore how important it is to first qualify as a radiographer to practise MRI competently. Secondly, it is evident that my research needs to include the professional implications of direct entry into MRI. There are only two published articles on specialism in radiography, both of which are historical and neither of which directly explores the personal experiences of those with a stake in this issue. No research has examined specialism in the context of MRI and there is no recent research into the impact of specialist practice in general. Several themes have emerged, including scope of practice, employability, professional fragmentation, registration and job satisfaction, all of which my research needs to explore. Therefore, the educational and professional aspects of this study are both important for me to gain a full picture of the research problem and to assess whether the undergraduate degree in MRI is the best way to educate MRI practitioners. The research design I choose, therefore, must be able to capture both

perspectives. This, and the research questions, concepts and theories that underpin my research, are explained and justified in the next chapter.

# CHAPTER 3: DESIGN



### 3.1. INTRODUCTION

The purpose of this chapter is to critically evaluate the development of a research design that allows me to address the central research question: how is it best to educate MRI practitioners? By drawing on the influences of Crotty (1998) and Punch (2009), I identify a scheme that shows how my research question informs my philosophical assumptions, theoretical perspectives, methodology and methods. The discourse clearly demonstrates how each of these elements fit together, including the location and justification of my epistemological position, a defence of the methodology used, and articulation on how this informs my theoretical perspectives.

It is important that my research design permits testing of the proposition that learning MRI represents a difference in, rather than an advancement of, knowledge, and that specialised undergraduate curricula with direct entry into practice might be the best educational model. Appraisal of the literature identifies very real concerns about early specialisation, such as professional fragmentation and limited scope of practice. Therefore, to investigate feasibility it is necessary to explore both educational and professional issues. The data for these two strands are different and, consequently, the choices I have made regarding my philosophical, theoretical and methodological perspectives reflect this. Thus, I used a mixed-methodology approach as the main construct of my research scheme.

In this chapter I apply two distinct concepts to design my study, inform my approach and justify the model I have chosen. I use them to develop the research plan by analysing the main research paradigms and articulating how my research philosophy has evolved. I also explore and justify the methodology and methods utilised in my research. I begin by showing how the literature informs my research design. Subsequently, I provide a clear description and justification of the variables I use and the relationship between them. Table 3.1. (p.59) defines and explains the terms I use throughout this chapter.

**Table 3.1 Glossary of terms used in Chapter 3**

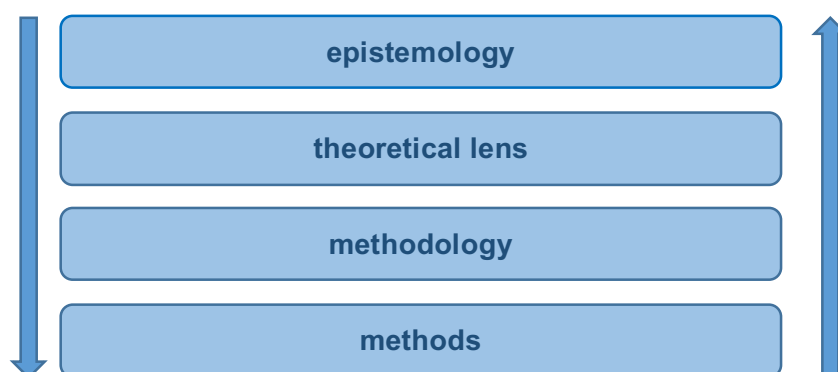
<b>ontological</b>	Relates to the nature of reality. Used to explain that reality exists outside of human consciousness (objectivism) or is a social construct of human consciousness (constructivism). <sup>1</sup>
<b>epistemology</b>	Relates to the theory of knowledge, how different realities are known and the distinction between justified belief and opinion. <sup>1</sup> Used to describe a range of perspectives including objectivism, positivism, post-positivism, constructivism, subjectivism and pragmatism.
<b>theory</b>	A collection of concepts and propositions to explain or predict a phenomenon. <sup>1</sup> The theories of Bloom's taxonomy, the Dreyfus' skills acquisition model and Benner's novice to expert continuum are the main theories used in this chapter.
<b>theoretical lens</b>	The lens that a researcher uses to view their research. These can be based on assumptions determined by the researcher's own opinions and experience or are characteristic of a theory. <sup>2</sup> An exploratory theoretical lens is used in this research as the purpose is to explore how best to educate MRI practitioners. This is based on my own opinions and experience but is also embedded in the theories of Bloom, Dreyfus and Benner
<b>conceptual framework</b>	Graphical representation of the main variables and their presumed relationship. <sup>2</sup> Figure 3.5 illustrates the conceptual framework on which this research is based.
<b>proposition</b>	A statement or assertion that expresses a judgement or opinion. <sup>2</sup>
<b>meta-theory</b>	Consideration collection of theories in which certain aspects are combined and linked. <sup>1</sup> Used to describe Bloom's taxonomy
<b>hypothesis</b>	A conjectural statement of the relationship between two or more variables. It is a supposition or proposition made on the basis of limited evidence as a starting point for further investigation. <sup>1</sup> The hypothesis of this research is stated in Section 4.3.1. and is based on a proposition explained in Sections 1.3 and 2.6.1.
Definitions from 1. Cohen, Manion and Morrison (2011) and 2. Punch (2009)	

### 3.2. MODELS OF RESEARCH DESIGN

Blaikie (2009) defines research design as ‘an integrated statement of, and justification for, the technical decisions involved in planning a research project’ (p. 15). A research design is how a researcher makes sense of the research problem. To be credible, each component must be congruent and it is important that the researcher engages in a reflexive and iterative process with these elements (Cobb, 2003).

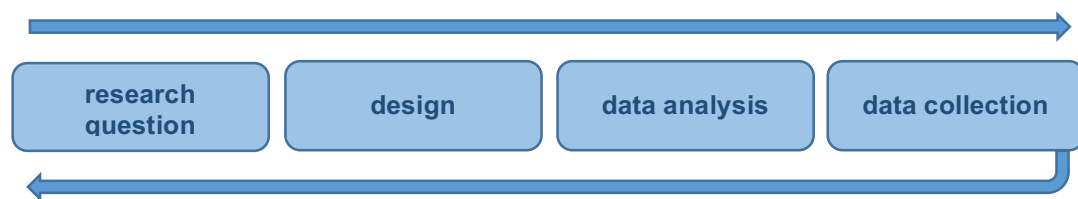
Crotty (1998) and Punch (2009) provide two distinct models for designing research. Crotty (1998) describes a linear model that consists of four components that inform each other, thereby ensuring a rigorous approach to research. The starting point is the researcher’s philosophical assumptions about how knowledge is gained through research. This informs the theoretical perspective that the researcher might use, which then influences the methodology or strategy implemented by the researcher. Finally, the methodology informs the methods used to acquire and interpret the data. This is a two-way model; therefore, it is just as valid to assume that the methods inform the methodology, from which a theoretical and epistemological position emerges (Figure 3.1.). Crotty (1998) posits that his model permits a sound defence of the methodology and methods employed in research and a deep analysis of the process, because it highlights the assumptions and philosophy that underpin the research.

**Figure 3.1. Linear model of research design (from Crotty, 1998. p. 4)**



By contrast, Punch (2009) supports a model in which the research questions play a central role. The starting point is framing the research in questions, followed by determining what data are required to respond to these questions. From this emerge the methods by which those data are collected, interpreted and used to answer the questions (Figure 3.2.). Both models emphasise the need for alignment between each of the four major elements of research design. The difference is the starting point of the design process.

**Figure 3.2. Research-question-centred design (from Punch, 2009 p. 11)**



Later in this chapter, I explain how I integrate the models of Crotty and Punch to develop my own research design. The common elements of a research plan, epistemology, theory and methodology are now discussed using the literature to support the decisions I make in developing the conceptual framework for this research.

### **3.3. EPISTEMOLOGY PERSPECTIVES**

#### **3.3.1. Research paradigms**

Collis and Hussey (2014) define a research paradigm as 'the progress of scientific practice based on people's philosophies and assumptions about the world and the nature of knowledge' (p. 46). Epistemology is concerned with what kinds of knowledge are knowable and how a researcher can know what is known. The nature of reality, and, therefore, the knowledge that explains that reality, underpins research: it is necessary to decide whether knowledge gained through research is something that occurs distinct from human experience or as part of it. Thus, how I as a researcher identify knowledge and understand reality is important (Rocco et al., 2003b).

Historically, there are two opposing epistemological paradigms, although some researchers have argued that it may be more appropriate to think of an epistemological continuum (Gray and Densten, 1998; Tashakkori and Teddlie, 2003). At one end of the spectrum is natural science or objectivism; at the other is humanistic social science, otherwise known as constructivism or interpretivism. Educational research literature makes a sharp distinction between these paradigms, but its significance has been questioned. Punch (2009) is a strong advocate for avoiding the philosophical high ground and allowing the research question to govern the researcher's epistemological position. Nonetheless, it seems to be important to understand these distinctions before relaxing them.

#### **3.3.2. Objectivism and constructivism**

Objectivism is a philosophical system of thought that declares that the goal of knowledge is simply to describe phenomena, not to question their existence. Ontologically, it asserts that reality exists as something separate from human consciousness or experience, including that of the researcher (Crotty, 1998). Objectivism claims that phenomena are real, regardless of the presence of a human mind to impart meaning to them. This is the traditional positivist paradigm view, which was first transferred from natural to social science by Auguste Comte in the 1830s and was subsequently supported by philosophers such as John Stuart Mill and Bertrand Russell. Positivism rejects any metaphysical or spiritual

abstractions. It posits that knowledge can only be considered as authoritative if it is based on scientific observation. Phenomena are measurable and quantifiable and can be generalised to everyone (Cohen, Manion and Morrison, 2011). The research question makes assumptions based only on the collection of quantitative data and the use of statistics to interpret data. This viewpoint holds that 'the numbers' reveal the truth about reality and the human mind is used only to discover what is already there. The researcher makes impartial scientific observations, is detached from those observations and collects empirical data, which are used to form irrefutable universal laws. From this standpoint, there is a belief that objective accounts of the world can be given (Crotty, 1998). Positivist research designs typically take a top-down, deductive approach, where a previously developed hypothesis or research question is tested by experimentation and a logical conclusion is drawn based on the evidence.

At the other end of the spectrum, constructivism's stance is that there is no meaning without the human mind. Contrary to objectivism, this viewpoint holds that 'the words' reveal the truth about reality and the human mind is pivotal. Based on the theories of Jean Piaget and Lev Vygotsky, ontologically, constructivism denies the existence of an objective reality and asserts that reality is a social construct of human consciousness and interaction (Patton, 2002). Although the existence of phenomena is accepted, meaning is constructed in a two-way dialogue with the phenomena. The phenomena contribute towards the meaning, but different people may construct meaning in different ways, even in the context of the same phenomena. Subjectivism develops this thinking further by assuming that phenomena make no contribution to meaning. Instead, meaning is imported from somewhere else, including metaphysical sources (Cohen, Manion and Morrison, 2011). From a research point of view, the researcher is no longer an impartial observer but part of the observation, and the participant and the researcher are jointly responsible for constructing their own meaning. The participant and the researcher bring meaning to situations, which they use to understand and interpret their own reality (Punch, 2009).

Constructivism and subjectivism are both anti-positivist paradigms that see the value of the meaning that humans place on their reality and how they interpret what is true. Constructivism and subjectivism are traditionally adopted by qualitative research designs, which use words rather than numbers as data; these words reflect the subjective thoughts, opinions and experiences of the participants and the

researcher (Patton, 2002). Anti-positivist paradigms may take a bottom-up, inductive approach to research in that there is no predetermined hypothesis. The starting point is the collection of rich qualitative data, which are explored in depth and from which a hypothesis might emerge.

Some literature attempts to simplify and converge the positivist and anti-positivist viewpoints by arguing that the distinction between these research traditions is a false dichotomy (Reichardt and Rallis, 1994; Rocco et al., 2003a). The historically polarised positions of positivism and anti-positivism also raise important questions about how to do sound research. Is there such a thing as objective truth, which can be measured with precision by the researcher, or does the researcher make their own truth based on their own assumptions of the world? Embedded in these questions is an implication of a profound difference in how research should be done and, therefore, the findings that emerge from it. According to Punch (2009), educational research values real-world data and data about human behaviour. Both are deemed scientific, because both accept the role of empirical data and theory. It is irrelevant whether the data precede the theory and whether the data are quantitative or qualitative.

Francis Bacon (1561–1626) is attributed as the first proponent of experimentation and observation to find out about the truth of reality (Crowther, 1960). This purely positivist school of thought was considered the only way in which we can know the truth of anything, and it is the foundation of the classical theory of physics established by Newton. Newton's very mechanical view of reality is based on the measurable observation of objects and how they react to external influences (Westbrook, Kaut-Roth and Talbot, 2011). However, in 1927 this theory was challenged by the German physicist Werner Heisenberg, who discovered that it is not possible to measure exactly the position and the velocity of an object at the same time, because the act of observing the object affects it (Jammer, 1974). An example is observing the wave-particle duality of a photon. It has been known for some time that photons of electromagnetic radiation sometimes act as waves and at other times act as particles, depending on how they are measured experimentally. In the 1980s, John Wheeler, an American physicist, took this one step further by discovering that the act of observing a photon is what ultimately determines whether it behaves like a particle or a wave (Vincent, 2007).

Heisenberg's uncertainty principle identifies a built-in unpredictability to nature; therefore, even the most scientific empirical positivist viewpoints cannot be defended as legitimate ways of establishing reality or used to say categorically what is known (Crotty, 1998). Even the most traditional and long-standing scientific laws are disputable and are often modified or even entirely discarded. Consequently, positivism has had its detractors and in the last few decades a post-positivist viewpoint, developed by scholars such as Karl Popper, has emerged. This paradigm supports the scientific method, but it acknowledges that observers may affect what is being observed, there are many uncertainties, there are many things we cannot know, and all findings are conjectural (Crotty, 1998).

However, the purely anti-positivist stance cannot make hard claims of truth and certitude either. Qualitative researchers investigate human behaviour and the reasons that govern it (Cohen, Manion and Morrison, 2011). Truth and reality are human constructs and are determined by human experience and consciousness. Therefore, reality is relative to an individual's perception of that reality and there are many different versions of the truth. The researcher's own social and reality construct may be overlaid onto those of the participants in their research, adding to subjectivity even further (Punch, 2009). Arguably, there is no difference between these two paradigms anyway. In one process, numbers are broken down and inferences are made using a statistical tool. In the other, words and sentences are broken down into themes and inferences are made using a qualitative tool. Both paradigms require human interpretation to make sense of the data, whether they are quantitative or qualitative.

### **3.3.3. Pragmatism**

Pragmatism is a set of ideas articulated by several scholars, including John Dewey, William James and Charles Sanders Peirce (Creswell and Plano Clark, 2011) and advocated by many authors, including Tashakkori and Teddlie (2003) and Punch (2009). It is located between the positivist and anti-positivist extremes, where practical and applied philosophies are more important than traditional ones. The characteristics of the pragmatic world-view include a pluralistic, problem-centred, real-world approach to research. Whilst isolating itself from the metaphysical concepts of truth and reality, pragmatism sees value in both objective and subjective knowledge and is positioned towards what works in practice. The



research questions are more important than the underlying method or epistemological stance. Pragmatism has been condemned for being too simplistic and compromising and for being linked to practical outcomes instead of a critical exploration of causes. Reality is something to be explored rather than analysed and evaluated (Crotty, 1998).

However, pragmatism is embraced as the best paradigm for mixed-methodology research, because its assumptions are well suited to merging quantitative and qualitative strands to provide a better understanding of a research problem (Tashakkori and Teddlie, 2003). The researcher is free to choose whatever methods fit the research question rather than entrench themselves in one philosophical camp. Pragmatism sees the importance of assessing a variety of different inputs and recognises the fact that problems are commonly solved using numbers and words. Like pragmatism, in mixed-methodology research the research question takes centre stage (Cohen, Manion and Morrison, 2011). Creswell and Plano Clark (2011) are strong advocates of the importance of recognising that post-positive and anti-positivist viewpoints might be relevant in a mixed-methodology context. Researchers need to honour both viewpoints when designing their research, especially if the design has different phases. The authors contend that in this type of scheme, world-views can shift and change during the research process. However, they also acknowledge that when qualitative and quantitative data are collected in the same phase, the pragmatic, all-encompassing world-view is best (Creswell and Plano Clark, 2011).

Later in this chapter I show why I have adopted a pragmatic philosophical perspective in my research and show how it aligns with the other elements in my research design.

### 3.4. THEORETICAL PERSPECTIVES

Silverman (2006) defines a theory as a set of concepts used to explain or define a phenomenon and emphasises its importance in research by saying, 'without a theory there is nothing to research' (p. 14). However, he also argues that although theories provide the impetus for research, they are self-confirming and force the researcher to look at the world in a certain way. Punch (2009) explains that research can either verify or generate theory. In the 'theory first' approach, the starting point is a theory from which a hypothesis is constructed and tested. This approach relies on theory-verification and differs from the type of research that results in a theory that emerges from the data. Advocates of the 'theory after' approach, such as Glaser and Strauss (1967), argue that the verification of existing assumptions inhibits the exploration of new problems. This is especially important in areas of new research, where there are few existing theories to verify (Strauss and Corbin, 1994).

Qualitative social science researchers advocate the importance of the theoretical or interpretive perspective that a researcher brings to their research. Crotty (1998) defines a theoretical perspective as 'the philosophical stance that lies behind a methodology' (p. 66) and that is deemed an essential component of research design. Creswell (2009) emphasises the importance of placing a discussion about the theoretical model or conceptual framework at the beginning of the research-design process. The theoretical lens that a researcher uses to view their research is based on assumptions. These may be informally determined by the researcher's own opinions and experience of the research problem, or they may be more formal assumptions that are characteristic of a specific social research theory (Creswell, 2009).

What are the most appropriate theories to use in my research? Educational theory that relates knowledge and skills to different educational levels seem intuitive. The proposition on which this research is based is that learning MRI might not involve advancing knowledge already acquired at undergraduate level but could represent different knowledge and practice to general radiography. Consequently, undergraduate level study might be a better way of learning MRI than other educational methods. Postgraduate learning typically involves highly complex cognitive processes and, in specialised imaging modalities such as MRI, this

requires pre-existing knowledge that is already understood and applied. The SCoR stipulate that MRI practitioners must build upon knowledge already gained via their radiographic undergraduate learning and develop increasingly more complex understanding of subjects such as anatomy, technology and physical principles (SCoR, 2015). A justification for this research is that undergraduate radiography programmes are designed to provide only a basic understanding of these subjects. Whilst this may enable practitioners to meet the requirements of the HCPC to assist in MRI examinations, it is not sufficient pre-existing knowledge for unsupervised practice or for those embarking on postgraduate courses in MRI.

There are many examples of postgraduate curricula that do not necessarily rely on students having pre-existing subject knowledge. The QAA (2015) describe different types of master's courses which include specialised or advanced scientific programmes that result in the award of Master of Science (MSc) and professional or practice master's programmes such as the Master of Business Administration (MBA). They explain that MSc courses are usually attractive to applicants who already have subject-specific knowledge acquired through previous study at bachelor's level. Their aim is to enable students to specialise in a subject area in which they have prior knowledge or experience. This differs from professional or practice related postgraduate programmes, such as the MBA, where a bachelor's degree or experience that may or may not be directly relevant to the professional content of the programme is required. These types of master's programmes may also integrate postgraduate and undergraduate level study within a single programme (QAA, 2015).

One of the reasons that postgraduate curricula with core modules in MRI are given the award title of MSc is that there is an expectation that practitioners are building on pre-registration knowledge gained via the bachelor's degree in radiography (SCoR, 2015). These courses are intensely subject related. Practice in MRI has a given problem and there is a given solution defined by under-pinning theory that has deep foundations. All aspects of practice rely on a thorough understanding of these physical principles which are embedded in complex and difficult mathematics. Profession or practice related postgraduate programmes in subjects such as business, finance or management are more generalised. The goal is to build professional skills that students can apply in many different professional situations (Cameron, 2011). The ability to draw and reflect upon memories of previous experience is important in both types of master's programmes, but the link between

theory and the ability to apply that to different scenarios is much more subjective in profession or practice based programmes than those designed for learning in a subject related course such as MRI (Cameron, 2011).

According to the national occupational standards in MRI, competent MRI practitioners must demonstrate a sound understanding of theoretical knowledge and this must be applied in a range of clinical situations (Skills for Health, 2008). Eraut's (2000) analysis of the development of professional expertise, particularly in the early stages of a practitioner's career has foundations in the Dreyfus skills acquisition model (Dreyfus and Dreyfus, 1980). Eraut distinguishes between tacit or implicit learning and deliberative learning. Implicit learning is the acquisition of knowledge through sub-conscious linkage of memory with current experience (Klein, 1989; Reber, 1993; Eraut et al., 1995). Deliberative learning on the other hand, involves the conscious use of prior knowledge and application to new situations. Prior knowledge can be acquired formally through a prescribed and organised learning framework or through situational learning (Eraut, 2000). Progression to a competent level of practice involves the acquisition of deliberative knowledge by accessing formal knowledge and learning through experience. The initial stages of professional development into a competent practitioner require standard routines and explicit rules and the individual learns to link these to different scenarios (Dreyfus and Dreyfus, 1980). In the context of MRI this means developing a sound understanding of physical principles and being able to apply them to some basic task-orientated procedures (Caruana and Plasek, 2006). For example, a competent MRI practitioner is expected to understand the theoretical principles behind parameter selection within pre-defined protocols and then apply those principles in routine clinical examinations (Skills for Health, 2008).

Progression beyond competence to proficient or expert practice is associated with gradual replacement of deliberation by more tacit forms of cognition (Eraut, 1995). The difference between being competent and being proficient is realised in the practitioner needing less supervision and being competent in a wider range of situations (Dreyfus and Dreyfus, 1980). In the context of MRI this means that a practitioner is not only able to apply their formal understanding of the physical principles of MRI in pre-defined imaging protocols, but also able to develop this understanding in complex situations. They may, for example, develop new protocols for the diagnosis of unexpected pathologies or new techniques. They are expected to change and modify parameters to suit different patients and equipment

(Westbrook and Talbot, 2009). This type of practice requires a sub-conscious, tacit knowledge of under-pinning theory and is linked to expert practice. Research literature on expertise consistently finds that the distinguishing feature of experts is their ability to use their knowledge in complex and new situations (Schmidt and Boshuizen, 1993). Experts are differentiated from the proficient or competent practitioner because they can handle the most difficult problems that require a wider knowledge base and have very a critical approach to complicated problems. The cultivation of this kind of expertise requires a very different form of learning than that needed for the development of competency and proficiency (Eraut, 1994).

How then are the different stages of Dreyfus' skills acquisition model linked to the most appropriate levels of education in the early stages of a practitioner's career in MRI, and how should curricula be designed to facilitate learning both formally and experientially? The problem seems to focus on how best to enable the development of a deep understanding of knowledge and how to apply that knowledge in a range of situations. Practitioners need to establish which areas of knowledge are relevant, then reflect on what knowledge is required for a particular action and then ascertain how that knowledge is interpreted in different contexts. Authors such as Schön (1983) have argued that reflection lies at the centre of nearly all significant learning and curricula must include reflective and reflexive learning. However, it is also necessary to develop an educational model that is fit for purpose. Salomon (1998) distinguishes between forward-reaching and backward-reaching educational models. The forward-reaching approach anticipates that certain kinds of knowledge are likely to be useful in the future. Salomon argues that this is the purpose of nearly all the taught components of professional and vocational education. Backward-reaching transfer is required when an individual faces a new situation and deliberately searches for knowledge they have already acquired (Salomon, 1998). Eraut et al., (1998) suggest that one of the problems of transferring knowledge from initial qualification programmes into postgraduate education is the conflict between the forward transfer ideology of higher education and the backward transfer approach expected in the workplace. He argues that the failure of HEIs to recognise the nature of the further learning required to make education more useful in the workplace as 'disastrous'. Any educational strategy should therefore ensure that it successfully meets the expectations of the workplace and enables a practitioner to access and apply knowledge at a competent level.

This discourse has demonstrated that there are many theoretical considerations to my research that rely on the linking of different levels of practice with developing and applying knowledge. There is a requirement in MRI to initially establish core underpinning knowledge and to successfully apply this knowledge in routine situations before progressing onto new or more complex contexts. Educational theories that rely on a hierarchy of knowledge and skills, where lower levels of achievement are a requisite for the development of more complex behaviours are therefore relevant to my research. These are Bloom's taxonomy and Benner's novice to expert continuum, both of which refer to the Dreyfus' skills acquisition model.

### **3.4.1. Bloom's taxonomy**

Bloom's taxonomy of educational objectives is a descriptive meta-theory that provides a framework for classifying what educators expect their students to have learned by the end of a programme of study (Krathwohl, 2002). It can be viewed as a sequence of progressive contextualisation of knowledge. The taxonomy is an epistemological hierarchy, but it also has a chronological element in that it is usually necessary to achieve the lower levels before other levels that are higher up. Bloom's taxonomy identifies categories of learning behaviours. The first three levels are generally accepted as those required by students to demonstrate fundamental knowledge, understanding and application in their field of study. The next levels are associated with higher-order thinking skills (Anderson et al., 2001; Dunn et al., 2004).

Bloom's taxonomy is commonly used to design educational curricula by mapping the desired learning outcomes to each of Bloom's classifications. According to Atherton (2013), a higher contextualised level of cognition associated with analysing and evaluating is expected at postgraduate level, whereas lower-order thinking skills, such as knowledge, comprehension and application, are more appropriate at undergraduate level.

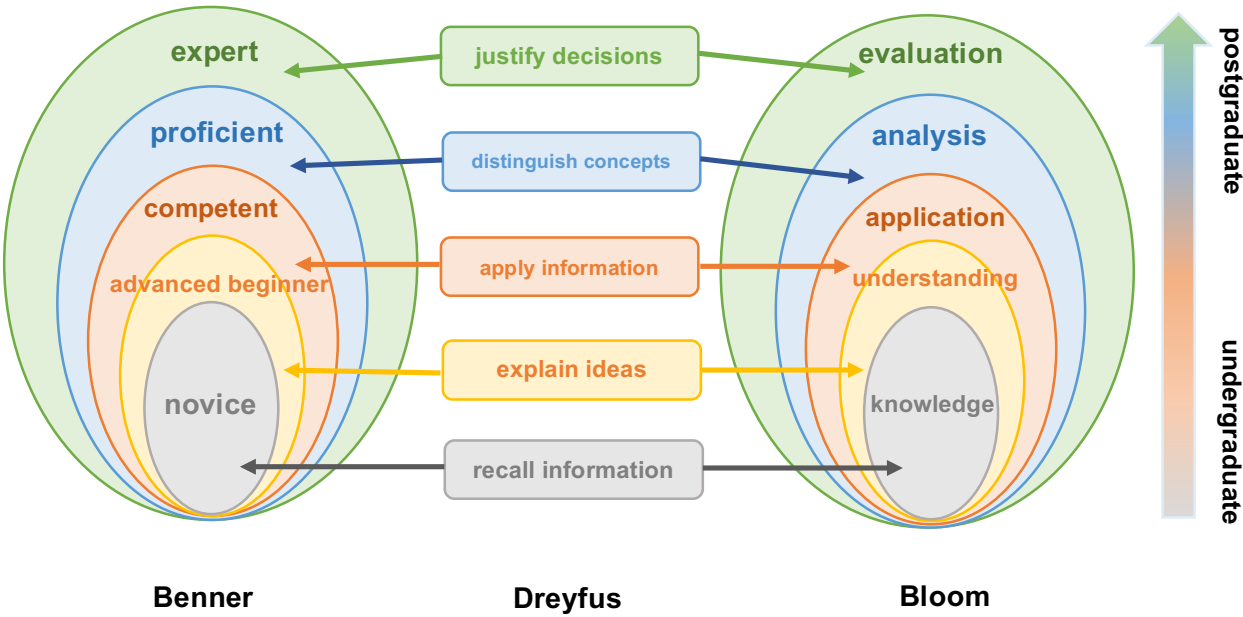
### 3.4.2. Benner's novice-to-expert continuum

This theoretical construct is based on Bloom's taxonomy and the Dreyfus skills-acquisition model (Dreyfus and Dreyfus, 1980). The Dreyfus model is a construct that shows how a learner develops skills through formal teaching and practice. A student develops competence by active decision-making as a result of organising principles and assessing rules (Pena, 2010). Patricia Benner uses the Dreyfus model and combines it with Bloom's taxonomy to develop her own hierarchy in nurse education (Benner, 1984). Her model describes five stages of clinical proficiency, from beginner to expert. A novice is identified as a practitioner with no knowledge, confidence or experience, who requires repeated cues to perform a task safely. Advanced beginners have progressed to a stage where their knowledge is developing; they are proficient in some areas of practice but still lack confidence in others. As their knowledge and confidence develops, after two or three years the practitioner progresses to the competent stage. The competent practitioner is efficient and organised and can apply knowledge to different problems effectively. Advancement to the next level (proficient) enables a practitioner to use their experience to differentiate between typical and unusual scenarios. They can take a more holistic approach than the competent practitioner can. The highest level of competency (expert) is recognised by the practitioner having an intuitive grasp of situations. Expert practitioners are highly skilled and have fine-tuned analytic abilities (Benner, 1984).

Benner's five levels of competency from novice to expert have characteristics that are similar to the five classes of cognitive development described by Bloom. Figure 3.3. (p.73) attempts to map these similarities. It shows that a competent practitioner (as defined by Benner) requires knowledge, understanding and application (identified by Bloom) and the skills of recall, explanation and application (identified by Dreyfus). In the context of MRI, a competent practitioner is one who can apply their knowledge and understanding of MRI theory to manipulate imaging parameters to suit different patients and pathologies (Skills for Health, 2008). This level of skill, therefore, appears to fit well with Benner's and Bloom's third stages of development. If these concepts are combined with Atherton's (2013) assertion that the outcomes of undergraduate curricula align with a student's ability to apply knowledge and understanding, it seems reasonable to assume that the first three stages of Bloom and Benner are associated closely with an undergraduate

curriculum. The final two stages are more strongly linked to higher-order cognitive skills and the levels of competency associated with postgraduate curricula and advanced clinical practice.

**Figure 3.3. Benner, Dreyfus and Bloom**



Later in this chapter I show how the adoption of an exploratory and possibly transformative theoretical lens, and the theories of Bloom and Benner, are used in interpretative phase of my research. The conceptual framework illustrated in Figure 3.5. (p.91) illustrates the relationship of the elements to others in my research design.



## 3.5. METHODOLOGICAL APPROACH

### 3.5.1. Mixed methodology research

Mixed methodology is relatively new in educational research, although its prevalence is increasing. Surveys examining trends in educational journals in the last 20 years report a high prevalence of mixed-methodology research design: between 25% and 33% (Collins, Onwuegbuzie and Jiao, 2007; Hart et al., 2009; Alise and Teddlie, 2010; Ross and Onwuegbuzie, 2010). However, mixed-methodology research is still new in healthcare, especially in the allied health professions. To date, there are only a few examples of this typology: some in radiography research literature and some in professions, such as physiotherapy and nursing. For example, Van Den Bergh (2015) strongly advocates the value of mixed methodology in physiotherapy research as a way of strengthening the validity of complex data and permitting a more holistic approach to its interpretation. He sees this as key, given the need for multi-factorial approaches to health problems. In medical education research, mixed-methodologies have particular value, especially in research on new and complex initiatives (Schifferdecker and Reed, 2009); this seems to be congruent with an investigation into a novel approach to educating MRI practitioners.

There are several definitions of mixed-methodology research and there is a lack of consensus on how to define it. Variations stem from different views about what is being mixed and when the mixing occurs, and about the rationale for mixing different types of data (Johnson, Onwuegbuzie and Turner, 2007). Tashakkori and Teddlie (1998) define mixed-methodology research as 'the combination of qualitative and quantitative approaches in the methodology of study' (p. ix). This definition reflects the view that mixed methodology does not just mean a mixing of methods; it also has a methodological orientation that includes epistemological positions and theoretical inferences. There are concerns about the incompatibility of mixing two paradigms, but advocates of mixed-methodology research argue that using different approaches to collect and integrate data yields additional strengths, which often result in research that is superior to that which uses single methodologies (Johnson and Onwuegbuzie, 2004; Johnson, Onwuegbuzie and Turner, 2007). Creswell and Plano Clark (2011) argue that mixed-methodology research offsets the weaknesses of purely quantitative or qualitative methodologies. Quantitative approaches do not usually take the participant's voice

or the researcher's bias into account, but qualitative data are arguably deficient because of the interpretation the researcher places on the data and the difficulty of generalising findings to a larger population. Combining the strengths of both types of data makes up for their individual weaknesses (Creswell and Plano Clark, 2011).

However, mixed-methodology research has its challenges and these have led to a slow adoption of this type of research in the social and healthcare sciences (Ponterotto, Mathew and Raughley, 2013). The prevalence of quantitative research methodologies and positivist philosophies in these professions has led to a reluctance to embrace qualitative, anti-positivist paradigms in the same study (Lonner, 2009). In addition, mixed-methodology research requires that the researcher has skills in qualitative and quantitative research. Creswell and Plano Clark (2011) suggest that researchers gain experience and the requisite skills in both types of research before undertaking a mixed-methodology study. They emphasise the need for a researcher to understand issues connected to quantitative research, such as hypothesis testing, statistical analysis, reliability, validity and generalisability. They also advocate that researchers acquire qualitative research skills in areas such as methods of data collection and analysis, coding themes, and issues surrounding credibility and transferability. Another consideration is that it is sometimes difficult to convince others of the merits of using a mixed-methodology approach. There is a fear that mixing methodologies dilutes the efficacy of the research, because the researcher tries to do too much in a single study; and the mixing of epistemological stances is anathema to some traditionalists (Tashakkori and Teddlie, 1998).

### **3.5.2. Mixed-methodology design**

According to Creswell and Plano Clark (2011), there are many considerations when selecting a mixed-methodology design. These include the priority of each strand (quantitative and qualitative), the timing of collecting the data from each strand, and when and how the data from each strand are merged. Several designs are described, including explanatory, exploratory and transformative models. As I have identified exploratory and transformative lenses as appropriate perspectives through which to view my research, exploratory and transformative mixed-methodology designs were initially investigated, but were discarded in favour of a convergent design. This is because, according to Creswell and Plano Clark (2011),

exploratory designs are chosen when the researcher wants to assess a research problem that is primarily qualitative in nature. These types of studies are usually constructed in two phases, where initial data informs new emergent research questions. This type of mixed-methodology study is theory-generating; therefore, it is not appropriate for my research, especially the quantitative strand.

Transformative models are chosen when the researcher wishes to address a transformative aim, especially for marginalised populations (Creswell and Plano Clark, 2011). Although my research has the potential to inform change in how MRI practitioners are educated and it may be appropriate to view its findings through a transformative lens, the research is not influenced by any particular transformative ideology.

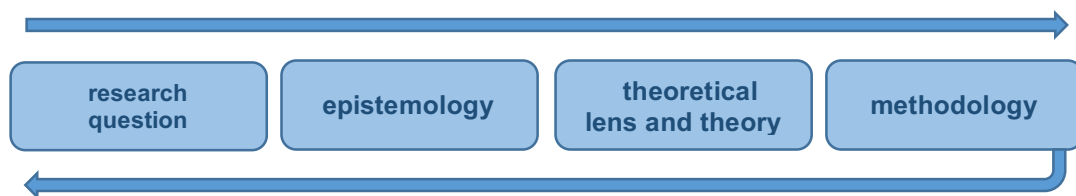
The convergent design is the most popular mixed-methodology model. It was initially conceptualised as a triangulation design, where two different methods are used to triangulate findings on a single topic. Currently, the term *convergent design* is used when the researcher constructs a model of research in which quantitative and qualitative data are collected at the same time and the two sets of results are combined in the interpretative phase. The purpose of the convergent design is 'to obtain different but complementary data on the same topic' (Creswell and Plano Clark, 2011, p. 77). The purpose, therefore, is to combine the strengths and non-overlapping weaknesses of quantitative methods with those of qualitative methods.

Having used the literature to discuss the key elements of research design, I now justify the choices I have made in planning my research. The different elements are explained and justified and the relationship between them is illustrated in Figure 3.5. (p.91).

### 3.6. CONCEPTUAL FRAMEWORK

The stance that I have chosen to take in the development of my research scheme is that what my research is endeavouring to find out is pivotal. My focus is directed towards the problems under investigation and the practical consequences of my research. These concerns take priority over the methods or the theoretical and philosophical assumptions. The research questions inform these elements. Furthermore, rather than starting from an entrenched epistemological position or viewing my research through a particular theoretical lens, I have been directed to the most appropriate paradigm view by the problems my research addresses and the questions my research needs to answer. Therefore, I have chosen to incorporate both Punch's and Crotty's ideas by assuming that my research question is the starting point but incorporating each of the components identified by Crotty and showing how they fit together (Figure 3.4.). This leads to the construction of the conceptual framework of my research, which is explained in detail at the end of this chapter (see Figure 3.5. p.91).

**Figure 3.4. Implemented research design**



#### 3.6.1. Primary research question

To research effectively, it is necessary to define a research question in such a way that enables the researcher to be clear about what data are required (Punch, 2009). There needs to be a close fit between the question and the data. The process of question selection involves linking data to concepts; this enables the researcher to organise their research, delimit and focus the area of inquiry, and provide a framework for structuring the research, pointing the researcher to the data that are needed (Punch, 2009).

Silverman (2006) advocates that researchers should be aware of historical, political and contextual sensitivities when defining their research question. Historical sensitivity enables the researcher to avoid the trap of thinking that only present-day versions of social problems are problematic by defining research topics in the light of the examination of relevant historical evidence. Political sensitivity helps the researcher define the research problem against a backdrop of the influence that politics and policy have on the development of social science issues. Contextual sensitivity enables recognition of the fact that apparently uniform institutions and professional tribes take on a variety of meanings in different contexts. Although Silverman stresses the importance of making use of these three perspectives to discover the complexities and realities of the social world, he acknowledges that they are often contradictory and that it is not possible to capture them all. However, he claims that an insensitivity to these issues may lead to defining a research topic from a rather narrow, problem-based stance.

To capture these sensitivities, the review of the literature in Chapters 1 and 2 includes a historical exploration of the development of the specialist in healthcare practice and the associated development of educational curricula. This focuses mainly on the medical and nursing professions. However, literature that shows how models in nursing influence the development of radiography education is also reviewed. Policy documents from American, Australian and UK professional bodies (the ARRT, ASA and SCoR) are also explored to help define the research topic from a politically sensitive perspective. These documents specifically deal with how educational and professional policy has helped to shape and influence the structure of the radiographic profession and, consequently, how radiographers are educated in these countries. Contextual sensitivity is reflected in the inclusion of research that uses radiographic literature to define what is meant by specialisation in the context of diagnostic imaging.

The central problem under investigation is that current methods of educating MRI practitioners might be flawed, in which case a better way would need to be found. There might be a misalignment between the level of educational provision and the skills and competencies required for safe practice (Westbrook and Talbot, 2009). There is also a lack of standardisation and regulation of education and assessment of competencies in MRI (Castillo et al., 2016). The proposition on which this research is based is that a common undergraduate curriculum could standardise educational provision. It may also be the best way of educating MRI practitioners,

because learning MRI reflects a difference in, rather than an advancement of, knowledge. Consequently, the skills and competencies required of a practitioner, particularly at entry level, are best aligned with an undergraduate curriculum than other methods.

Keeping this problem and my proposition in mind, whilst incorporating an awareness of the different sensitivities that can shape research, the following overarching research question is identified:

*How do we best educate MRI practitioners?*

The wording of this question permits quite a broad approach but also enables me to investigate educational and professional perspectives of the research problem. This is important, because I have taken the view that any research into a different way of educating MRI practitioners would be incomplete without considering the professional implications of such an intervention.

Although I start from a broad perspective, I have avoided the pitfalls of exploring an unmanageably wide topic by narrowing it in several ways. Firstly, this research focuses solely on how best to educate MRI practitioners, not all types of imaging specialists. I have chosen MRI because this is my field of expertise and is a subject that matters to me on a professional and personal level. However, it is important to recognise that any arguments raised or recommendations made by this research could resonate with other imaging specialties, such as ultrasound and nuclear medicine. It may also be relevant to specialist practice in other healthcare professions, such as nursing.

Secondly, this research specifically investigates whether the introduction of a specialised undergraduate degree is the best way forward by comparing graduate with experiential learners, rather than comparing any other learning methods. To maximise the usefulness of this research, I have chosen to compare the proposed intervention with the most traditional educational pathway instead of the less common postgraduate or short course methods. It is also not possible to test practitioners who have learned MRI via a postgraduate programme in the USA because these do not exist. Inclusion of postgraduate learners would require inclusion of participants in countries such as the UK, Australia and New Zealand. It is important to recruit participants from the same country so that co-variables such

as workplace culture is reduced. Thirdly, it is my intention to make specific recommendations for the best way to educate MRI practitioners in the UK. Although data are collected in the USA and MRI education is a global issue (Castillo et al., 2016), this research makes recommendations for practice in the UK only. This is because the status and registration of imaging practitioners varies from country to country. Although the educational perspectives and problems are universal, the professional arenas are too diverse to be able to make any meaningful inferences upon them. Therefore, UK professional practice is the focus of any recommendations made by this study.

Defining my research question is relatively straightforward, but it is harder to determine the most honest and sound approach to take. Is it best keep an open mind about the most effective way to educate MRI practitioners at the beginning of my research and develop further research questions from which a theory can emerge? Or is it better to lay my cards on the table from the start and state a theory that I wish to explore through my research? Is an inductive or deductive approach the best way? Punch (2009) advocates making this distinction clear from the outset but emphasises that an inductive approach can soon develop into a deductive one as theories emerge from the data.

In Section 3.4, I discuss the merits of advancing a theory at the beginning of research or allowing a theory to emerge from the data. My area of research is one in which theory is scarce, as reflected by a lack of literature on MRI educational models. In this respect, a 'theory after' approach might be the best option. However, to develop a theory on the best way to educate MRI practitioners it would be necessary to explore and compare all types of educational paradigms, including experiential, formal and informal training programmes. This is not, I believe, realistic in the time frame of this study and it might limit my research to the educational perspective. Perhaps more importantly, it would be disingenuous to claim that I have a completely open mind about which educational method is best. I admit that I approach this research with a very clear proposition based on my professional experience as a leading MRI educator and previous personal research on this subject. Although I accept that using this proposition as a starting point might force me to look at my research in a certain way, I feel it would be dishonest to ignore this perspective altogether. Therefore, I have chosen to state from the outset that my overarching research intention is to test the usefulness of my proposition that undergraduate curricula are the best way forward. I accept that by

doing so I run the risk of limiting my investigation, but I defend this by arguing that my proposition is embedded in my lived experience of MRI education. By focusing on a specific educational method, there is room to explore the important professional aspects of this topic as well. Furthermore, this approach is commensurate with doctoral study, because my proposition is new.

Punch (2009) recommends the use of a hypothesis in deductive research design when the researcher has a proposition in mind at the beginning. A hypothesis is a predicted answer to a research question *a priori*. In scientific research, it is traditional for the researcher to establish a hypothesis that is tested through an investigation. But what is the basis for this prediction? Punch (2009) explains the importance of putting forward a set of propositions on which the hypothesis is founded. Consequently, by undertaking research, the theory behind the hypothesis can be tested. This hypothetico-deductive model seems to fit well with my research, because I have chosen to state a proposition from the outset. It specifically suits the educational, quantitative strand of this research as an objective assessment tool is used to compare the knowledge of MRI of two groups of MRI practitioners who have learned MRI in different ways. Analysing these data allows me to test the usefulness of my proposition directly. However, the qualitative strand is less clear in this respect. Based on interview responses from key stakeholders, this strand of the study is designed to investigate the professional benefits of, and barriers to, the introduction of a specialised undergraduate degree in MRI without the need for students to first qualify as radiographers. Whilst analysis of these data also permits testing of my proposition, it is important to allow room for inductive influences. The lived experiences and opinions of the respondents may allow new ideas to emerge. However, I am comfortable with this incongruity because mixed methodologies often involve the mixing of deductive and inductive viewpoints and the blurring of traditional distinctions (Tashakkori and Teddlie, 1998).

With these concepts in mind, the following proposition is identified as the basis of my research inquiry:

*The introduction of a specialist undergraduate degree programme in MRI might be a better way to educate MRI practitioners than experiential methods.*

To test this, my research must establish two things. Firstly, it must find out whether practitioners who complete a specialised undergraduate degree in MRI have a



higher level of MRI knowledge than those who learn MRI experientially because they have followed a standardised undergraduate curriculum. Secondly, my research must determine what professional impact early specialisation might have; specifically, whether there are any professional benefits of early specialisation and if these outweigh any barriers. Finally, both concepts must be integrated to test the proposition and ultimately address the feasibility and usefulness of the proposed new educational intervention in the UK. Further research questions emerge, therefore, and these are explained and justified in the next section.

### 3.6.2. Secondary research questions

The main research question is broken down into three secondary questions (summarised in Table 1.2.). Two of these questions address the educational and professional perspectives of the main research question. The third question combines both strands and addresses feasibility.

**Educational, quantitative research question:** *What is the relationship between the educational level at which a practitioner learns MRI and their residual knowledge of MRI theory?*

The first question focuses on the educational aspects of the research problem and seeks to identify whether there is a difference in residual knowledge between two groups of practitioners who have learned MRI in different ways (defined as graduate and experiential practitioners; see Section 4.2.1.). The term residual knowledge is used to differentiate working knowledge (as applied to practice) from knowledge recently acquired or memorised by rote and might be forgotten. Knowledge is sometimes differentiated from 'know-how' (Kline and Floyd, 2006). Knowledge (or 'know what') refers to explicit understanding about a topic. Know-how on the other hand is having the applied knowledge of how to accomplish a task. Know-how is a tacit knowledge and, unlike explicit knowledge, can only be acquired via practical experience in a relevant context (Fantl, 2008). In the context of MRI, there is a need to not only know the body of knowledge related to MRI theory, but also to be proficient in applying this knowledge in practice (Skills for Health, 2008). An OSCE was chosen as the method of data collection for the educational strand of this study because it is a good way of assessing explicit and tacit, applied knowledge (Muldoon, Biesty and Smith, 2014). This was designed to

test the residual knowledge of MRI amongst graduate and experiential practitioners as objectively as possible. The method and rationale that underpin this strand of the study are explained and justified in Chapter 4.

For the purposes of my research, an MRI practitioner is classified as anyone who performs MRI scans. This includes radiographers, nuclear medicine technicians, assistant practitioners and graduates of MRI educational programmes. The learning characteristics of MRI practitioners in each group are discussed in detail in Section 4.2.1.

**Professional, qualitative research question:** *What are the professional benefits of, and barriers to, early specialisation in MRI?*

The second question relates to the professional implications of the introduction of direct entry into MRI without the need to first qualify as a radiographer. This question is designed primarily to address the benefits of, and barriers to, such an intervention for the imaging profession. A semi-structured interview was chosen to collect data for the professional strand of this study by exploring the perspectives of a variety of stakeholders. According to Mears (2012), research questions commonly commensurate with the interview method address matters of the ‘what’ or ‘how’ as related to lived experiences. This method and the rationale that underpins the professional strand of the study are explained and justified in Chapter 4.

**Mixed-methodology research question:** *To what extent do the educational and professional perspectives explored in this study support the introduction of a specialised undergraduate degree programme in MRI?*

The third question combines the findings of the quantitative and qualitative strands to get a sense of how feasible it might be to introduce a specialised undergraduate degree programme in MRI in the UK. This was chosen in the tradition of a mixed-methodology approach to question-setting (Tashakkori and Teddlie, 2003). The aim was to see whether combining the qualitative interview data with the quantitative OSCE data supports the proposition that a specialised undergraduate degree might be a better way of educating MRI practitioners than experiential methods. The assertion is that lower OSCE test scores in the experiential group than in the graduate group, supported by interview data that reflect the need for change in the

way in which MRI practitioners are educated, might strengthen the argument for introducing specialised undergraduate programmes. Conversely, interview data that reflect that current experiential models of learning are fit for purpose, combined with higher OSCE scores in the experiential group, may weaken the argument for this intervention. In addition, any evidence from the interview data that supports the notion that graduate practitioners require less training than experiential practitioners is strengthened by higher OSCE scores in the graduate group.

Therefore, these research questions are central to my research design, as advocated by Punch (2009). I now show how they inform the epistemological and theoretical perspectives used in my research, which are the first two elements in Crotty's model of research design.

### 3.6.3. Epistemology

Before undertaking this research, I located myself very firmly at the positivist end of the epistemological spectrum. This is probably because all my previous research is quantitative and, therefore, I believed that my strengths lie in analysing and interpreting empirical data. Interpretative, inductive approaches were largely an anathema. It is not that I was particularly sceptical about the validity of qualitative data; rather, I saw them as too vague and intangible for the type of research I wanted to do. However, the development of my research design has made me question what is true and how we know what we know, even in positivist paradigms. As a result of the dialogue in Section 3.3.2, I am comfortable with discarding these philosophical distinctions and allowing my research question to determine my epistemological position. What I am trying to find out should drive the rest of the design, including my philosophical standpoint and, as shown in Section 3.3.3, this reflects a pragmatic philosophical perspective.

Pragmatism seems to be congruent with my research, because my inquiry involves very practical outcomes and is based upon a defined practical problem. I recognise, however, that the educational aspects of this study could align with a post-positivist, theory-verification perspective, because the research questions are based on a proposition that undergraduate curricula are the best way of educating MRI practitioners. The research design is guided by a proposition that is advanced at the beginning of research and either verified or dismissed based on the collection

and interpretation of empirical data. The professional aspects of this study could also be viewed from this post-positivist stance in that they also attempt to verify a proposition, albeit by collecting different types of data. However, they could also be congruent with the anti-positivist perspective in that transformative, theory-generating data might emerge. Pragmatism adopts a pluralistic approach to research, as it recognises that sometimes both approaches are relevant (Creswell and Plano Clark, 2011). Researchers adopting pragmatism still test hypotheses and verify theory, but they provide multiple perspectives in doing so. These perspectives might result in theory being generated at a later stage of the research. This further supports the adoption of pragmatism as the main epistemological perspective of my study, as both types of data are collected concurrently.

Having established the philosophical stance on which this research is based, in the next section I discuss the theoretical perspectives used to inform the process of my research. In doing so, I show how they provide a framework for quantitative and qualitative data-collection methods.

### **3.6.4. Theoretical lens and theory**

The importance of determining the theoretical lens through which research is viewed is discussed in Section 3.4. This is an aspect of my research design that I have struggled to pin down. What is the best theoretical perspective to take in my research? Is a general theoretical stance, such as exploratory or transformative theoretical lens, the best approach, or is my proposition that undergraduate curricula produce more knowledgeable practitioners than experiential methods characteristic of a specific educational theory?

There is an exploratory inference to my research in that I am endeavouring to investigate the issues surrounding early specialisation in MRI. However, a transformative ideology might also emerge, as the findings of my research may advocate change in the way in which MRI practitioners are educated. Greene and Caracelli (1997) link mixed-methodology design with transformative perspectives. They assert that diverse methodologies strengthen the claims made by one's research: an important attribute when advocating change. This is supported by the notion that to bring about a change in educational policy it will be necessary to show that graduate practitioners are more knowledgeable than experiential

practitioners, and that professional concerns about, and barriers to, early specialisation can be overcome. Having two types of data supporting the same conclusion is more likely to result in change than having a single type of data (Creswell, 2009).

In addition, my proposition that specialised undergraduate curricula are a better way of educating MRI practitioners than experiential methods is based upon well-described educational theoretical concepts. I investigated several theories of learning in my quest to determine an appropriate theoretical concept with which to frame my research, but none of the traditional paradigms of learning theory, such as cognitivism and constructivism, specifically relate to what I am trying to find out. As a pragmatic paradigm underlines the importance of the practical outcomes of my research, it is important to select theoretical concepts that align with these outcomes. Therefore, I turn to some pragmatic theoretical models, used in the design of educational curricula, for inspiration. I return to my proposition that specialisation in MRI represents a difference in knowledge rather than an advancement of prior knowledge. This proposition leads me to concepts that map levels of learning to different educational paradigms.

The theoretical constructs of Bloom's taxonomy and Benner's novice-to-expert continuum, therefore, are useful to justify the main proposition of my research. The concepts that surface from Figure 3.3. (p.73). reinforce the argument that the knowledge and practice of MRI are congruent with the competent practitioner as defined by Benner and Dreyfus. They, in turn, align with Bloom's descriptors for bachelor-level outcomes. Furthermore, the action words used in the lower three levels of the Dreyfus model and Bloom's taxonomy also appear to align well with those highlighted in blue in Table 1.1 (p.11). For example, words such as 'understanding' and 'application' are clearly linked to the Skills for Health national occupational standards for a competent MRI practitioner (Skills for Health, 2008) and the learning outcomes for a practitioner as defined by SCoR (2013a). They are also found in the QAA (2014) descriptors for bachelor-level study (see Table 1.1. p.11). In Figure 3.5. (p.91), these concepts are combined with the main exploratory interpretive lens through which I view my research. This involves taking a deductive approach to explore the issues arising from the research problem, but acknowledging that a transformative perspective might also emerge.

Having established the epistemological and theoretical perspectives of my research, I now explain and justify the main methodological approach used in my research design.

### 3.6.5. Methodology

A critical appraisal of the literature reveals that to find answers to my main research question – how do we best educate MRI practitioners? – it is necessary to consider educational and professional issues. The educational perspective relates to whether graduate practitioners have more residual knowledge of MRI than experiential practitioners. One way of assessing this is to test the working knowledge of MRI within each group of practitioners and compare their scores. This requires the collection and interpretation of quantitative data. The professional perspective relates to the impact that early specialisation might have on the imaging profession, including limited scope of practice and professional fragmentation. One way of assessing this is to question both groups of practitioners and other stakeholders to extract their views and opinions. This requires the collection and interpretation of qualitative data. Therefore, a mixed methodology emerges as a good way of capturing the educational and professional perspectives of this study.

As I have shown in previous sections, pragmatism, which has a pluralistic world-view, fits well with a mixed-methodology approach because it recognises that quantitative and qualitative, objective and subjective, and deductive and inductive stances are influential in my research. The research questions are designed to capture both views. The research questions identify the need to examine the educational as well as the professional aspects of a new intervention in MRI education and the feasibility of this approach is strengthened by the adoption of a mixed-methodology design.

A mixed-methodology approach is also justified because the theoretical lens through which this research is viewed requires gathering quantitative and qualitative data. To view my research through exploratory and, possibly, transformative lenses, the issues that surround the best way in which to educate MRI practitioners mean that educational and professional perspectives must both be investigated. In addition, a transformative ideology is more likely to materialise

from merging both types of data than from using only one. Creswell and Plano Clark (2011) assert that several types of research problem fit with mixed methodologies and that a very good reason for choosing this approach is when one type of data source may be insufficient to answer the research question. This seems especially congruent with my research inquiry. Research into whether early and exclusive specialisation in MRI is the best way forward would be incomplete unless it explored whether learning MRI at the undergraduate level improves residual knowledge and, at the same time, investigated the professional impact of this intervention. Therefore, a mixed-methodology design was chosen, because it might be a more rigorous way of answering the research question than a single-methodology study. Whilst having more data to solve the research question does not necessarily mean that the question is answered more thoroughly, if the methods align with the research question they should permit a rigorous collection and persuasive interpretation of both quantitative and qualitative data. This adds breadth to the process, because the tools of data collection and analysis are not restricted to one type of research (Creswell and Plano Clark, 2011).

However, as previously discussed, one of the challenges of mixed methodology research is the large amount of data generated and the need for the researcher to develop skills in both quantitative and qualitative methods. These ideas strongly resonate. As a researcher who was relatively unskilled in qualitative research at the beginning of this process, I acknowledge that choosing a mixed methodological approach has meant a very steep learning curve. Specifically, it has been necessary to significantly improve my awareness of qualitative methods and how best to collect this type of data. In addition, I have had to learn statistical and coding analysis software from the ground up. A purely quantitative or qualitative approach would have been far less time- and labour-intensive, but a mixed-methodology approach is necessary to capture the complexity of the phenomena under study.

As Figure 3.5. (p.91) shows I have chosen a convergent nested design. This typology is relevant to my research because the research question has educational and professional components and it makes sense that different types of data are required to answer the overarching research question. By using quantitative and qualitative methods, I can synthesise both types of data to develop a more complete understanding of how best to educate MRI practitioners. Creswell and Plano Clark (2011) support this concept: they recommend using a convergent

design when a pragmatic philosophical stance is adopted, because its assumptions are well suited to merging quantitative and qualitative data to provide a better understanding of a topic. They also advocate a convergent design when the researcher has limited time in which to collect the data. It was necessary to collect the data in the USA, because this is the main country in which undergraduate programmes specialising in MRI are delivered to practitioners who have not first qualified as a radiographer. Therefore, it is the main country in which graduate and experiential practitioners work alongside each other in the same department and where participants could be recruited for both strands of the study. Due to the time and cost limitations associated with travelling to the USA, it was only feasible to collect data for both strands of this research at the same time.

Therefore, the convergent design is the most intuitive and efficient type of mixed-methodology design (Creswell and Plano Clark, 2011). There are, however, several challenges associated with using this approach. It requires a great deal of effort and expertise in quantitative and qualitative methods, especially as the data are collected concurrently. For this reason, a convergent design is often adopted when there is a team of researchers. This is not the case in my research; therefore, I had to ensure that I had sufficient resources to address this challenge. Secondly, I had to attend to the consequences of having two different sample sizes and different participants in the two strands of the study. I also had to consider how best to merge two sets of very different data so that the qualitative and quantitative data addressed the same concepts. Comparison displays and data-transformation techniques are used and these are discussed in Chapter 4. There are also other philosophical challenges, such as what to do if the qualitative and quantitative data do not agree. Conflicts can lead to new insights but might also prove difficult to resolve. Additional data may be required or re-analysis of existing data may be necessary.

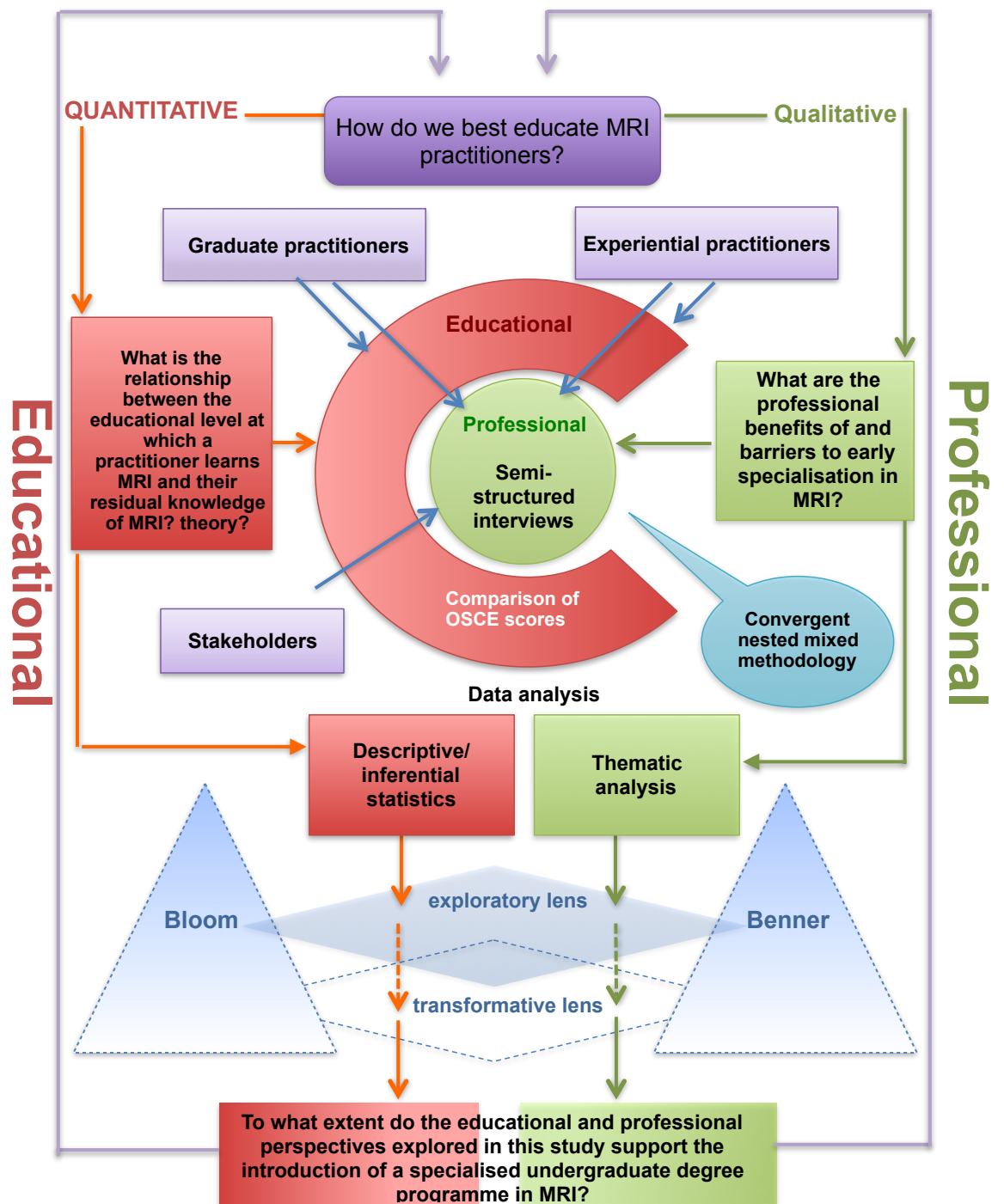
Further variations of the convergent design relate to the relative importance of the quantitative and qualitative data. Do they have equal importance or is one more dominant? In this variant, one method is predominant, with the other embedded or nested within it. This is appropriate when each strand addresses different aspects of the research question but one is thought to be more important than the other (Creswell et al., 2003). The nested variant is relevant to my research. Although the qualitative and quantitative perspectives are different, they are complementary. The educational issues are seen to be the most important, because they relate to



knowledge and competency, and, therefore, the ability to perform MRI examinations safely. Thus, the quantitative data, which address educational issues, predominate, and they are supported by the qualitative data on the professional aspects of the research problem.

My research design is conceptualised Figure 3.5. (p.91). This diagram shows how the different elements of the design align and fit together. The centre of the diagram shows how the professional aspects of my research (shaded green) sit inside the more dominant educational strand in a convergent, nested design. The data-collection methods used for each strand are embedded within this element of the diagram. The overarching, central research question sits at the top of the diagram (shaded purple). From this, the quantitative and qualitative research questions emerge. The left side of the diagram follows the educational, quantitative strand of this research through to statistical analysis of the OSCE data. The right side of the diagram follows the professional, qualitative strand of the research through to the thematic analysis of the interview response data. The bottom of the diagram illustrates how the two strands converge by connecting their findings to address the mixed-methodology research question. The analysis is viewed through exploratory and, possibly, transformative lenses, using the theoretical constructs of Bloom and Benner, and feeds back to the central research question at the top of the diagram.

Figure 3.5. Conceptual Framework



### 3.8. CONCLUSION

In this chapter I firmly align the four essential elements of a rigorous and defensible research design. From a pragmatic epistemological position emerges an exploratory and transformative interpretive perspective. A convergent nested mixed-methodology research design is selected. A dominant educational, quantitative strand is supported by a professional, qualitative strand. The quantitative strand requires an exploration of whether there is a relationship between the level at which a practitioner learns MRI and their residual knowledge of MRI. This aspect of my research quantitatively compares the OSCE scores of graduate and experiential practitioners as I define them (see Chapter 4). The qualitative data are collected concurrently. This requires an investigation of the professional benefits of and barriers to early specialisation in MRI. Themes such as limited scope of practice, patient care and job satisfaction are explored via semi-structured interviews with key stakeholders (see Chapter 4). The data are merged in the interpretive phase of the research to assess the feasibility of introducing a specialised undergraduate degree in the UK.

In the next chapter, the specific methods used to collect and analyse data are explained and justified

# CHAPTER 4: METHODOLOGY

## 4.1. INTRODUCTION

This mixed-methodology study uses a quantitative methodology to examine whether there is a relationship between the residual (or working) knowledge of MRI as it is applied to practice and the way in which MRI is learned. It also uses a qualitative methodology to explore the professional impact of early specialisation in MRI. Both methodologies are used to explore the feasibility of introducing a specialised undergraduate degree in MRI in the UK and, ultimately, to investigate how best to educate MRI practitioners.

In this chapter, I separately explain and justify the sampling, data-collection and data-analysis methods I have used in the quantitative and qualitative strands of this study. I discuss the validity, credibility and transferability of these methods and how the data are merged. I also consider the ethical aspects of my research. Unlike in the other chapters, most of the text that refers to what was done during the data-collection process is written in the past tense to reflect the historical nature of this event.

## 4.2. QUANTITATIVE METHOD

The aim of the educational, quantitative strand of this research is to address the following question:

*What is the relationship between the educational level at which a practitioner learns MRI and their residual knowledge of MRI theory?*

To do this it is necessary to assess and compare residual MRI knowledge between two groups of practitioners who have learned MRI in different ways with the purpose of determining whether one way of educating MRI practitioners might be better than the other. According to Miles and Huberman (1994), 'you cannot study everyone, everywhere, doing everything' (p. 27). Therefore, the researcher must develop a sampling strategy that fits with the research questions. Decisions include determining the sites of the research, the participants who provide the data and how they are sampled, the sample size required to answer the research question successfully, and the recruitment procedures (Miles and Huberman, 1994).

### 4.2.1. Sampling strategy

Forty-eight participants from four different clinical sites in the USA were included in the educational, quantitative strand of this study (n=25 and n=23; see Section 4.2.3. for the justification of this sample size). The educational, quantitative research question highlights the relationship between how MRI was learned by two distinct groups and the residual knowledge in these groups. It was necessary, therefore, to purposively select participants who fit into these groups to maximise the chance of observing any relationship between them and make comparisons as clear-cut as possible (Punch, 2009; Silverman, 2010). The characteristics of each group were carefully defined to ensure that an accurate comparison could be made between two different ways in which MRI is learned. Participants were selected if they had been trained to acquire images for the purpose of clinical diagnosis (defined as MRI practitioners) in one of the following ways.

*Graduate practitioners* (n=25) had been educated initially and exclusively in MRI and, therefore, they had entered the profession directly. These practitioners did not possess a radiographic qualification. Their professional education in MRI was at

degree level only. Practitioners who had learned MRI in this way were selected because this specific educational method is under scrutiny in my research.

*Experiential practitioners* (n=23) had been educated initially in radiography at degree level and went on to practise MRI post-qualification. Their MRI learning was only experiential. Practitioners who had learned MRI experientially were selected because this is the most common educational model (Castillo et al., 2016).

Practitioners in both groups were educated to degree level (therefore, they were all graduates) and were MRI practitioners. The difference between them is how they had learned MRI. The graduate practitioner group (as I have defined them above), had learned MRI via only a formally assessed undergraduate curriculum in MRI, whereas the experiential practitioner group had learned MRI only experientially (Table 4.1.). To keep the comparison as clear as possible, practitioners who had learned MRI via other methods or a mixture of methods were excluded.

**Table 4.1. Participant profile: quantitative, educational strand**

	Degree in radiography	Degree in MRI
<b>Graduate practitioners (n=25)</b>	No	Yes
<b>Experiential practitioners (n=23)</b>	Yes	No

Table 4.2. (p.97) illustrates the average experience of the graduate and experiential groups in years. This was calculated by dividing the total years of experience in each group by n. The experiential group had a higher average number of years of experience in MRI than the graduate group, reflecting the fact that undergraduate MRI programmes are relatively new and that experiential learning is the most traditional and long-standing educational pathway. The minimum experience in the experiential group was 1.5 years and the maximum was 30 years. In the graduate group, the minimum was no experience (0 years) and the maximum was 16 years. The participant with 16 years of experience had worked as an assistant practitioner in MRI for several years before completing the undergraduate MRI programme more recently.

**Table 4.2. Experience in MRI in years**

	Graduate (n=25)	Experiential (n=23)
Average experience in years	6.08	13.02

Access was a key part of the sampling strategy and was guarded by gatekeepers at each site. Permission from the clinical manager at each site was required and ethical approval was sought. Sampling procedures were, therefore, controlled and limited by several individuals and this impacted on which sampling methods were feasible. Probability sampling is more typical of quantitative studies, where the purpose is usually to make generalisations and so representativeness of the wider population is sought (Cohen, Manion and Morrison, 2011). However, generalisability was not seen to be as important as sampling participants based on the way in which they had learned MRI. Therefore, purposive sampling was chosen as the most realistic way of ensuring that enough appropriate comparative data were collected to address the quantitative research question within the timescale.

#### **4.2.2. Recruitment**

Forty-eight participants from four different clinical sites in the USA were included in the educational, quantitative strand of this study. These sites were chosen because each is affiliated to four different HEIs that deliver an undergraduate programme in MRI. There are no complete records of all the HEIs in the USA that deliver undergraduate programmes in MRI, but the ARRT has the most complete list. All HEIs on the list were contacted to see if they would be prepared to participate in this study, and most responded. The HEIs were chosen because they have long-standing undergraduate degree programmes, and, therefore, they have a large enough number of graduates. In addition, the MRI programme directors at these HEIs have kept a database of their graduates and have close clinical affiliations with local hospitals, as these sites are used for the clinical placement of students on the programme. Therefore, they have good access to graduate and experiential practitioners who work at the same clinical sites and they were able to recruit participants to this study.



The distribution of participants is shown in Table 4.3. It was important to recruit participants from each group who worked together in the same clinical environment so that co-variables, such as workplace culture, MRI equipment and patient demographics, were minimised. To maintain anonymity, participants were asked to draw a numbered ball from a box to ensure that identifiers were randomly allocated. To enable instant category recognition, even numbers were used for experiential practitioners and odd numbers were used for graduate practitioners. The number drawn by each participant (called the ID number) was used to place the participant within the appropriate group, but it was not linked to the participant in any other way.

**Table 4.3. Distribution of participants**

Practitioner	Site 1	Site 2	Site 3	Site 4	Total
Graduate	8	5	5	7	25
Experiential	6	7	4	6	23
Total	14	12	9	13	48

On my arrival at each clinical site, every participant was given a participant information sheet and an informed consent form (see Appendices 1 and 2). These conformed to the requirements of Anglia Ruskin University and were approved by the Faculty Research Ethical Panel (see Section 4.7. and Appendix 3). Separate ethical approval at each site in the USA was not required, because my research involved educational tests and interviews with de-identified participants only (see Section 4.7.). Each of the gatekeepers was provided with the research proposal, which they used to inform potential participants about my research prior to my visit. The gatekeepers endeavoured to recruit as many graduate and experiential practitioners as possible from the clinical site affiliated with their HEI. However, recruitment depended on how many MRI practitioners were free on the day of my visit. Some practitioners who had expressed a willingness to participate could not do so because of their work or other commitments on the day.

### 4.2.3. Sample size

Twenty-five (n=25) graduate and twenty-three (n=23) experiential practitioners (total: n=48) participated in the quantitative, educational strand of this research. It was not possible within the time frame to recruit a larger number of participants. Relatively few HEIs in the USA provide an undergraduate degree in MRI and many of the HEIs I surveyed had lost track of the location of their graduates. The American educational and healthcare system is quite state-focused, which means that many institutions do not keep records of individuals who have moved out of the state. Therefore, it was not always possible for an HEI to locate participants or to know whether any of their MRI graduates were clinically active. Thus, there was a relatively limited pool of potential participants to draw from. In addition, it was not possible to obtain equal sample sizes. It had been my intention to do so; however, after the data-collection period, a different number of practitioners from each group had participated.

According to Cohen, Manion and Morrison (2011), there are no clear answers to the question of optimal sample size. In quantitative research it is usually necessary to obtain a sample size that accurately represents the larger population being targeted. This requires an understanding of the total population size. From this, the optimal quantitative sample size can be calculated based on the required levels of accuracy and probability. In my research, this calculation was difficult because there are no records of the size of the total population of graduate practitioners in the USA and there are only estimates of the total numbers of experiential practitioners. Furthermore, there are no national records of how experiential practitioners learn MRI.

A sample size of 30 is held by many to be the minimum number of participants if statistical analysis is planned (Cohen, Manion and Morrison, 2011). Borg and Gall (1979) also suggest that comparative experimental research requires a minimum of 15 participants in each group. This argument is supported when using sample size calculation methods that involve Cohen's effect size, desired statistical power and probability. This type of calculation recommends a sample size of 26 in each group using a two-tailed hypothesis (Jones, Carley and Harrison, 2003). In the light of these suggestions, the quantitative sample size used in my research is reasonable but limited, and it falls short of the optimal sample size of several hundred when

using parameters such as confidence levels and intervals (Jones, Carley and Harrison, 2003).

To maximise the sample size, I considered producing an online version of the OSCE. I have access to a database of MRI practitioners who belong to an educational MRI organisation in the USA, and it might have been possible to recruit a large number of participants from this and ask them to complete the OSCE online. However, this approach was discounted. It is technically possible to assign a time limit to each section of an online OSCE, but what cannot be known is whether participants are using books or other resources to answer the questions. It is also impossible to ascertain whether participants are completing the OSCE as individuals or conferring in groups. It was important to ensure that the OSCE scores were as true a representation as possible of the residual knowledge of each participant on the day of the test, and it would have been impossible to guarantee this via the online method. This approach would not necessarily have resulted in a larger sample size anyway. The response rate to online data-collection methods is notoriously low (Denscombe, 2009), even if participants' anonymity is ensured and the collection methods are relatively benign. The OSCE is a form of examination that is, perhaps, more off-putting than other online data-collection methods, such as questionnaires. Thus, it is possible that participants would have been less likely to respond to an online request to complete an examination; thereby restricting, rather than increasing, the sample size.

Therefore, a larger quantitative sample size was sacrificed in favour of including participants who had the most relevant educational and clinical backgrounds and using reliable data-collection methods. Given the constraints, I am satisfied with the sample size for this strand of the study. The potential drawbacks of a limited quantitative sample size are moderated by the fact that participants were recruited from four different sites in four different states, providing a good range of participants and clinical experience. There is no reason to believe that the participants were unrepresentative of the general population of graduate and experiential MRI practitioners. I recognise that the relatively small sample size limits the statistical power of this study, but it should still be possible to make inferences with some degree of confidence. It is also important to note that there is a professional, qualitative strand to this study; therefore, it does not rely on the educational, quantitative strand alone. This is considered one of the benefits of the mixed-methodology design and is one of the reasons why I took this approach (see

Section 3.7.1.). Problems such as small sample sizes, which could be significant in a quantitative-only study, are not as important when different types of data are merged and analysed (Creswell and Plano Clark, 2011).

#### 4.2.4. Methods

To find the best method to answer the educational, quantitative research question, it was important to define *residual knowledge* and determine whether it is possible to measure it. Is there a continuum of greater or lesser amounts of residual knowledge, and is it constant or in an unpredictable state of change? (Punch, 2009). For the purposes of this study, residual knowledge is defined as knowledge remembered, understood and applied, rather than knowledge memorised, revised or recently acquired for an examination. This definition is used to differentiate knowledge acquired by rote from knowledge that a practitioner needs to apply to acquire optimally diagnostic MR images safely. This is the most useful type of knowledge when investigating the best method of educating MRI practitioners, as it refers to 'know-how' knowledge as applied to practice (Benner, 2004; Kline and Floyd, 2006). If the underpinning theory and hypothesis are to be tested effectively, only residual knowledge defined in this way is important. There is little value in testing knowledge that relies on memorising recently acquired facts, and it is not possible to know what level of knowledge any of the participants had when they first learned MRI.

Residual knowledge is a continuum that can be measured using a variety of educational assessment tools. Questionnaires and surveys are common quantitative research methods but neither is appropriate to assess MRI theory, because they are both too narrowly focused. Essays and other types of written discourse are traditional in the educational arena, especially when assessing higher-order learning, such as critical thinking (Dunn et al., 2004). However, knowledge, understanding and application are also commonly aligned with quizzes and multiple-choice questionnaire (MCQ) examination assessment methods (Biggs, 1990). If designed correctly, this type of assessment tool can assess breadth and depth of knowledge at the same time. Therefore, I have chosen a method for the quantitative strand of this study that is based on this type of assessment but has been modified to capture a wide variety of topics related to the application of MRI theory.

#### **4.2.4.1. OSCE**

In healthcare, an assessment tool called an OSCE is a common variation of the MCQ. The OSCE is a versatile, multi-purpose evaluative tool that allows the testing of a wide range of topics. It was first introduced in the 1970s as a means of assessing the theoretical knowledge and practical skills of medical and nursing professionals (Harden, Stevenson and Downie, 1975). It has now become widely accepted as a strategy for assessing underpinning theory and clinical competence across a range of allied health professions (Muldoon, Biesty and Smith, 2014). A typical OSCE involves students progressing through several time-limited tasks, where skills relating to a variety of topics are assessed. These topics range from theory-testing via written answers to simulated practical clinical scenarios.

The main characteristic of an OSCE is that, compared with other assessment tools, it is considered a more robust and objective way of assessing knowledge. Objectivity is preserved by selecting questions and answers that are not open to the interpretation or judgement of the assessors (Habeshaw, Gibbs and Habeshaw, 1993; Forward and Hayward, 2005). This is achieved by using a form of questioning that has a single correct answer established by a predetermined grading system. In addition, the standardised time limit for each task means that every participant has the same amount of time to complete the same set of questions. These strategies reduce subjectivity and, therefore, increase reliability (Sloan et al., 1995; Nicol and Freeth, 1998; Dunn et al., 2004; Kirton and Kravitz, 2011). The literature advocates the OSCE as an effective assessment method, because it allows participants to develop practice and improve clinical skills (Brosnan et al., 2006), links theory and practice (Nicol and Freeth, 1998) and permits simultaneous testing of numerous individuals on a wide range of topics (Mitchell et al., 2009). The conclusions of Kirton and Kravitz (2011) also lend credence to the argument that an OSCE is an invaluable tool for assessing clinical competency.

There are, however, recognised limitations and concerns over reliability and validity. Firstly, the OSCE is not necessarily the best way of assessing higher cognitive thinking skills. Although Dunn et al. (2004) suggest that MCQs can sometimes extract this type of information, OSCEs are typically used for assessing the lower-order thinking behaviours as suggested by Anderson et al. (2001). This, though, is congruent with the remembered, understood and applied knowledge I

need to investigate in my research. It is also considered to be the type of cognitive thinking that aligns best with residual or working knowledge (Anderson et al., 2001). Strategies that ensure the validity and reliability of the OSCE include the need to prepare and pilot questions and grading systems carefully (Rushforth, 2007).

The OSCE questions used in this research are similar to those used by Westbrook and Talbot (2009). In the 2009 study, questions were selected from a large bank of OSCE questions that had been developed in 2006 by a team of MRI educationalists and practitioners on behalf of the ARRT. This international team were tasked by the ARRT to develop questions on a range of topics for their MRI registry review examination. The content specifications of this examination are based on a unified entry-level MRI education curriculum by the American Society of Radiologic Technologists (ASRT), the Association of Educators in Imaging and Radiologic Sciences (AEIRS), and the Section for Magnetic Resonance Technologists (SMRT) of the International Society of Magnetic Resonance in Medicine (ISMRM). This curriculum is informed by a systematic review of the MRI profession by practice analysis of a nationwide sample of MRI practitioners which describes the responsibilities and competencies of an MRI practitioner employed at entry level (ARRT, 2008; ARRT, 2014).

The United States Bureau of Labour (Occupational statistics – radiographers and MRI technologists, 2017) identify that there are over 230,000 radiography posts in the USA, but do not specify what proportion of these practise MRI or have completed the ARRT registry review examination. ARRT statistics indicate that nearly 11,000 candidates undertook the examination between 2011 and 2016 (ARRT, 2016) and Weening, Gilman and Greenidge (2012) report similar figures between 2006 to 2011. Therefore, approximately 22,000 MRI practitioners have participated since the examination was established in 2006, but there are no official records of what this represents as a percentage of the total number of MRI practitioners in the USA. The ARRT examination is well-established with a significant number of registrants (Weening, 2012). The questions used in the examination are thought to be well-tested and therefore a useful source of questions for research purposes.

Table 4.4. (p.104) aligns each section of the ARRT examination with the ARRT curriculum content specification. The ARRT MRI certification examination consists of 200 questions, which cover five major content categories: patient care, imaging

procedures, sequence parameters, data acquisition and physical principles of image formation (ARRT, 2014). The questions are heavily weighted towards MRI physics which include questions on pure physics, as well as theory applied to clinical practice (Weening, 2012).

**Table 4.4. ARRT examination MRI registry examination topics**

Section	Topic	Curriculum Content
1	Patient Care	legal aspects of healthcare, safety, hospital policy, anatomy and pathology
2	Imaging procedures	pulse sequences and image contrast
3	Sequence parameters	image optimisation
4	Data acquisition	image production and processing
5	Physical principles	general principles of MRI

The OSCE questions used by Westbrook and Talbot (2009) were organised differently to the ARRT examination to reflect the characteristics of their participants and the requirements of the Department of Health, who commissioned their research. Firstly, the total length of the OSCE was reduced to enable testing of their participants in the time frame provided for the research. In the ARRT examination, participants are given 25 minutes to answer questions from each section and the total examination time is therefore over 2 hours long. Westbrook and Talbot (2009) were required to test nearly 50 participants in a short time-frame and therefore the total number of OSCE questions was reduced whilst still reflecting the topics covered in the ARRT examination. Westbrook and Talbot randomly selected questions from the ARRT database in each section, but some were excluded because they were not considered appropriate for their UK and European participants. For example, Section 1 of the ARRT curriculum includes content on US legal and hospital policy which were not relevant to the participants in Westbrook and Talbot's study. Consequently, these questions were omitted and questions on MRI safety, anatomy and pathology were isolated. In addition, the Department of Health required that Westbrook and Talbot assess participant's ability to use medical terminology as some were from countries in which English is not the first language. Questions on image production were replaced with those relating to medical terminology. Image production was chosen because the researchers felt that it was the topic least applied to practice in terms of assessing a practitioner's ability to scan patients and therefore the least valuable topic to

assess. Finally, Westbrook and Talbot re-ordered the sequence of topic questions as they felt that it was necessary to test participant's knowledge of the general principles of MRI before other physics topics as this subject refers to underpinning principles. In the ARRT examination, general principles are assessed last (Section 5) rather than at the beginning of the test.

Westbrook and Talbot (2009) performed a small pilot study on 3 individuals, unrelated to the main study, to test the validity and efficacy of the OSCE. Two were MRI practitioners who had qualified as radiographers and had learned MRI experientially. They were tested to assess whether the OSCE questions could be answered in the allocated time frame and were appropriate for testing knowledge applied to clinical practice. The third individual was a non-medical person with no previous exposure to MRI. This individual was selected to ascertain the number of answers that could be correctly answered by guessing alone (Westbrook and Talbot, 2009). The MRI practitioners in the pilot study scored 72% and 75% which correlated with expected ARRT examinations scores (ARRT, 2007) and appeared to validate the level, range and quantity of questions. The non-medical individual scored 16% by guessing some of the multiple-choice answers correctly, particularly in the medical terminology section. This was a slightly higher score than the researchers expected based on research in multiple-choice testing methods (Burton, et al, 1991; McKenna and Bull, 1999) who provide estimates of 10% for chances of guessing a correct answer. In response, Westbrook and Talbot adjusted the number of questions in the medical terminology section of their OSCE to reduce influence of guessing an answer correctly.

In my research, I used the same questions and sequence of sections as Westbrook and Talbot except that I replaced questions on medical terminology with those on image production. This is because the participants in my research are from an English-speaking country so I did not consider it necessary to assess their knowledge of medical terminology. I replaced these questions with questions randomly selected from the ARRT database on image production so that the questions reflected the same topics as the ARRT examination. In addition, I asked participants to leave a question blank if they could not volunteer an answer. This strategy was designed to reduce the influence of guessing an answer correctly on the findings. Westbrook and Talbot (2009) found that a significant number of their participants scored poorly in the OSCE and they surmised that this was due to a lack of knowledge of their participants rather than the design of the OSCE. This



conclusion was based on the fact that with the exception of questions on medical terminology, the questions were selected from the ARRT database that had already been used to assess applied knowledge of MRI practitioners in the USA. In this research, I have chosen to use the same questions as Westbrook and Talbot as it might be useful to compare the findings and determine if there is any correlation between them. There is no reason to believe that the participants in their study (who were all MRI radiographers and had learned MRI experientially) were any different to the experiential practitioners in my research, and therefore it might be possible to develop some useful comparisons in the discussion phase of this research.

Table 4.5 compares the ARRT, Westbrook and Talbot (2009) and this research in terms of the structure and content of each section of the OSCE.

**Table 4.5. A comparison of the OSCE structure.**

Topics	ARRT	Westbrook Talbot	This research
MRI safety, anatomy and pathology	Section 1	Section 1	Section 1
General principles	Section 5	Section 2	Section 2
Image contrast and pulse sequences	Section 2	Section 3	Section 3
Image production	Section 4	not tested	Section 4
Image optimisation	Section 3	Section 5	Section 5

In this research, the OSCE was divided into five sections of 20 answers each (total: 100). Some questions required participants to select more than one answer, so not all sections contained 20 questions (see Appendix 4). These sections were divided into the following topics:

- Section 1: MRI safety, anatomy and pathology (12 questions, 20 answers).
- Section 2: General principles (15 questions, 20 answers).
- Section 3: Image contrast and pulse sequences (20 questions, 20 answers).
- Section 4: Image production (16 questions, 20 answers).
- Section 5: Image optimisation (14 questions, 20 answers).

Most of the questions were multiple choice, where the participants selected one or two answers, but some questions required a written answer. However, in all cases there was only one possible correct answer. None of the participants had prior knowledge of the questions and none of them were informed of exactly what topics would be covered. The gatekeepers were not shown the OSCE before data collection and they were asked to ensure that none of the participants undertook any revision. During the OSCE, participants were not allowed access to books or other resources and this was monitored by me and the gatekeepers. These strategies were designed to ensure that the OSCE scores were as accurate a representation as possible of the residual MRI knowledge of each participant at the time of the test.

Every participant wrote their identifying (ID) number on each sheet of the OSCE, and each was given clear written and verbal instructions on how to complete the OSCE before the test began. As part of these instructions, all participants were asked to tick or write down their assessment of the correct answer (depending on the type of question). They were also instructed to leave a question blank (not answer it) if they could not volunteer an answer. The purpose of this was to reduce the number of answers that were guessed correctly and to assess the number of questions participants did not volunteer an answer for. Unlike questions that participants believed they could answer (and answered either correctly or incorrectly), the questions left blank indicated where participants had identified a gap in their knowledge. At each HEI, the gatekeeper and I invigilated the OSCE to ensure that all participants undertook the examination under the same conditions. Every participant was given a new section to complete every eight minutes. This time frame was chosen as optimal based on a previous study using the same method (Westbrook and Talbot, 2009). At the end of each eight-minute period, the participants were asked to stop writing. The completed section was removed and replaced with the next section, which had another eight-minute time limit. This process continued until the OSCE was completed (40 minutes in total).

#### **4.2.5. Design considerations**

Issues such as validity and generalisability are evaluated in the light of the findings of this study in Section 6.6. At this stage, it is important to consider the overall

design of this strand of the study and examine the potential limitations and pitfalls. Quantitative research is typically used to conceptualise reality in terms of variables and studies the relationship between them (Punch, 2009). Well-developed data-analysis techniques usually bring objectivity to the process, because they increase the chances that the research findings are not influenced by the researcher. Punch (2009) describes two types of quantitative experimental design: those that are comparative and those that are relational. The first is termed the true experiment and involves a 'look downwards' approach, where the researcher investigates causes (independent variables) and their effects (dependent variables). Although the wording of the educational, quantitative research question implies a relational study, the comparative model is more appropriate, because the research question requires a comparison of the residual MRI knowledge between two groups of practitioners. The independent variable is the way in which MRI is learned, whereas the dependent variable is participants' residual MRI knowledge as determined by their OSCE scores.

The basic idea of my experiment is that the two comparison groups are set up, a different intervention is applied to each group (the way in which they learn MRI), and then the residual knowledge between the two groups is compared by measuring their OSCE scores. The intention is to say that any differences in participants' residual MRI knowledge as measured by their OSCE scores were caused by the way in which they learned MRI. However, this attribution is based on the assumption that the groups are alike in all other respects. To minimise differences, it was necessary to select participants who had the same clinical exposure, MRI equipment and scope of practice. This was assured by recruiting participants from the same healthcare culture and the same type of clinical environment, which is one of the reasons why all the participants were recruited from the USA.

In addition, it was important to consider variables other than the way in which MRI was learned that might confound or confuse the interpretation of any differences in the OSCE score. The only way to be certain that any differences were due exclusively to the way in which MRI was learned would have been to assign participants to each group randomly (Punch, 2009). However, this experimental design was not practical and a quasi-experimental design was adopted. This is common when the researcher has no control over the independent variable but does have control over how and when to measure the dependent variable (Cohen,

Manion and Morrison, 2011). This is relevant in the context of my study because the participants naturally fall into groups based on how they learned MRI. Quasi-experimental designs acknowledge the other influences that might affect the outcome, measure them and remove them. According to Punch (2009), the use of quasi-experimental designs is legitimate because they maximise internal validity by enabling inferences to be made more confidently about the effect of the dependent variable on the independent variable. Accounting for variance is recognised as a crucial step in the development of the research design and in the analysis stage of the research. Although Punch (2009) says control-variable analyses are valuable in many research situations, how does this apply to my research? Can, and should, the variables be co-varied out, or is it more practical to acknowledge them at this point and discuss them later in the light of my findings? The potential co-variables that might influence the level of residual knowledge include how long ago MRI had been studied by the practitioners in each group, how long they had been practising MRI, what their individual learning styles were, and whether their knowledge of MRI had been previously assessed.

Whilst I recognise that the way in which participants learned MRI is not the only measure of their residual knowledge, I believe that, at this stage, it is important to focus on what my research is trying to achieve. The quantitative research question does not ask whether there is a relationship between residual knowledge and experience of MRI, or whether knowledge has been previously assessed. Although these variables are recognised, it is not feasible to explore other relationships within the constraints of this research. Therefore, I have chosen to consider their potential impact on my findings in the discussion phase of my research, rather than try to account for variance during data collection and analysis (see Section 6.5). I acknowledge that I cannot necessarily get the full picture of how residual knowledge relates to how MRI is learned and there are recognised variables that might affect the OSCE scores. However, it is important to note that practitioners in both groups are graduates, albeit in different subjects; therefore, the level to which they have been educated should be similar. Thus, the characteristics of gradueness are assumed to be the same. This concept and the effect that graduate skills might have on learning are discussed later in Section 6.5.

### 4.3. QUANTITATIVE ANALYSIS

The purpose of analysing the quantitative data was to investigate whether there is a relationship between how MRI is learned and residual knowledge of MRI theory, as measured by the OSCE scores. The assumption was that the higher the score, the greater the level of residual knowledge of MRI. The OSCE answers from each group were marked using controlled grading criteria, which reflected as objectively as possible the knowledge of graduate and experiential practitioners (DeLisa, 2000). A spreadsheet was used to record the number of correct and incorrect answers and the number of questions not answered for each participant (see Appendices 5a and 5b).

The overall scores for graduate and experiential practitioners were compared directly using statistical tools. Descriptive statistical analysis was performed using spreadsheet software (Numbers version 3.6, Apple Inc) to calculate and graphically illustrate the total scores for each group. The mean, median, mode, standard deviation and variance of the scores for each group were also calculated. Inferential statistical analysis was performed using third-party statistical calculation software (Wizard for Mac version 1.7.9).

A requirement of inferential statistics is to set a testable hypothesis, identify the problems raised by the hypothesis and, from this, select the most appropriate analysis tools. The research hypothesis used in the educational, quantitative strand of this study is now explained and justified.

#### 4.3.1. Hypothesis testing

Quantitative analysis is commonly based upon the development of hypotheses that are tested using statistical tools (Cohen, Manion and Morrison, 2011). The research hypothesis is a definite statement that posits an inequality between variables and can be either non-directional or directional. A non-directional hypothesis reflects a difference between the two groups, but the direction of the inequality is not specified. This differs from a directional hypothesis, where a clear statement is made about the direction of the inequality (Salkind, 2014). Non-directional and directional hypotheses are also expressed in terms of one- or two-tailed testing. A directional hypothesis is tested using a one-tailed test, as it specifies in which

direction one variable will differ from another. A non-directional hypothesis is tested using a two-tailed test, as a particular direction of difference between the variables is not specified (Salkind, 2014).

Initially, I considered using a one-tailed test, because the hypothesis that I am testing is that graduate practitioners have a greater level of residual knowledge of MRI than experiential practitioners, as graduate practitioners study MRI via a specialised undergraduate curriculum rather than experientially. This implies directionality but it is based upon my own proposition rather than any established theory. Therefore, a more stringent two-tailed test was applied to reflect the expectation that there was an equal chance that graduate or experiential practitioners could score more highly overall. A two-tailed test was also used when looking at differences between the two groups in the number of questions that were not answered. This reflects the expectation that each group had an equal chance of not being able to volunteer an answer to a question.

The specific hypotheses that are tested in the analysis phase of this study are formulated here.

**Hypothesis:** *Graduate practitioners have more residual knowledge of MRI theory than experiential practitioners.*

**Null hypothesis:** *Graduate practitioners do not have more residual knowledge of MRI theory than experiential practitioners.*

The null hypothesis forces the researcher to begin from an unbiased viewpoint (Cohen, Manion and Morrison, 2011). It assumes that if there is any difference in the OSCE scores between the two groups, this is due to chance. Chance factors could include unreliability in the OSCE, such as in setting the questions and guessing the answers. Good research tries to eliminate the contribution made by these chance factors and, therefore, evaluate the contribution of other factors (Silverman, 2006). Conversely, the hypothesis is a statement of an expected event, which is that graduate practitioners have more residual knowledge of MRI theory, as measured by their OSCE scores, than experiential practitioners. The importance of first qualifying as a radiographer is not directly tested but is implicit. If graduate practitioners do have more residual knowledge of MRI than experiential practitioners then it may not be necessary to be a radiographer to practise MRI

competently. If, however, they do not have more residual knowledge then it might be necessary to first qualify as a radiographer. Indeed, lower OSCE scores in the graduate practitioner group might be caused by this factor.

### 4.3.2. Testing for significance

The purpose of inferential statistical tools is to test for any vulnerabilities in the null hypothesis (Salkind, 2014). Statistical significance is defined as how much risk a researcher is willing to take that the null hypothesis will be rejected even though it is true. The risk taken in making this error or defining the level of significance is known as a Type I error. Type II errors are made when a false null hypothesis is accepted. In general, only Type I errors can be controlled, because the level of significance is set by the researcher. Type II errors are especially sensitive to sample size because, as the sample size increases, and, therefore, more closely matches the population, it becomes less likely that a false null hypothesis is accepted. As the sample size in this study is quite small, it is important to keep the possibility of making a Type II error in mind during data analysis. However, at this stage only Type I errors are considered.

According to Salkind (2014), most researchers use a criterion of 0.01 or 0.05 as a benchmark for testing the truth of a hypothesis. Although a significance of 0.01 might be seen as the most rigorous option, in general it is considered to be too stringent in most scientific research, because it occasionally allows the rejection of a true hypothesis (Cohen, Manion and Morrison, 2011). A level of significance of 0.05 ( $p < 0.05$ ) is accepted as the usual criterion for the rejection of the null hypothesis, and this is the standard adopted in this study. By doing so, I accept that there is a 5% chance that the null hypothesis will be rejected even if it is true. Statistical significance is not, however, necessarily congruent with meaningfulness. Non-significant results could still be meaningful and significant results could have very little usefulness (Cohen, Manion and Morrison, 2011).

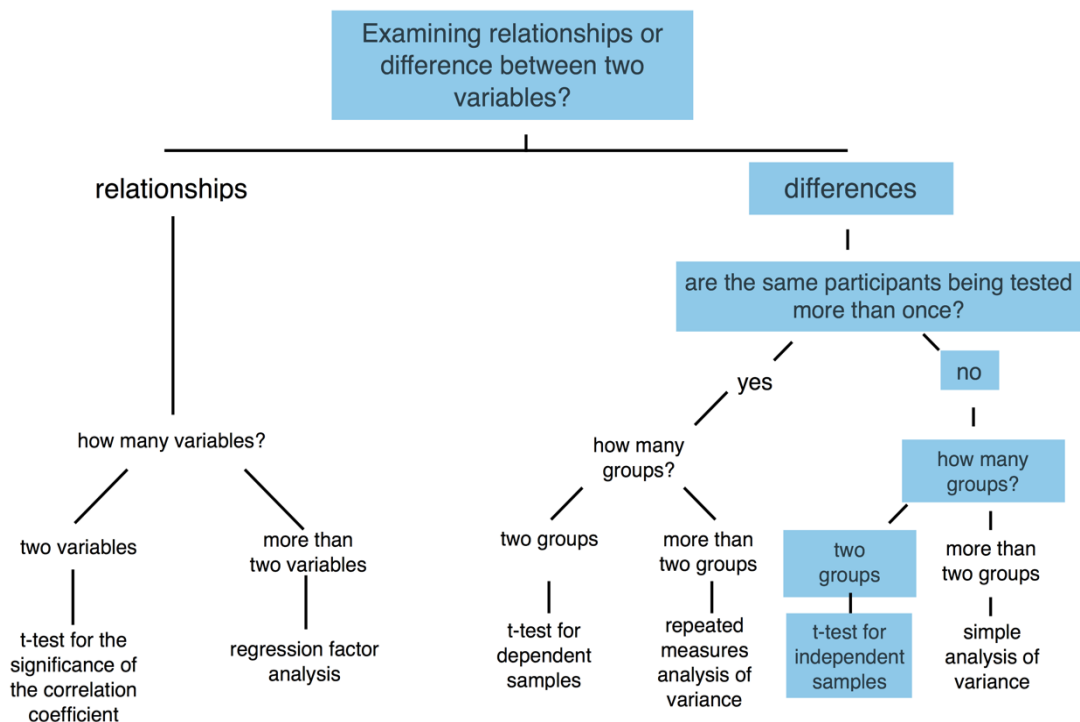
Before selecting the most appropriate test for significance, it is important to establish how normally the data are distributed and the homogeneity of variance (Salkind, 2014). The quantile-quantile (Q-Q) plot is commonly used to check the distributional assumption for each data set. It is derived by computing the expected value for each OSCE score for each participant based on the distribution. If most of

the data fall on a straight line, these data follow the assumed distribution (Bryk and Raudenbush, 1988). Homogeneity of variance, or homoscedasticity, states that the two groups are similar regardless of the level of the independent variable (Salkind, 2014). Levene's test is a common test for homoscedasticity and is used in this study to examine whether the variances in the graduate and experiential OSCE scores should be treated as statistically different. This is important because most statistical tests assume that the variances are homogeneous. Finally, the degree of freedom used in the inferential statistics testing uses the formula  $n-1$ . This is because the subtraction of 1 from the sample size forces the standard deviation to be higher than it would be if only  $n$  were used as a denominator in statistical formulae. This means that an unbiased estimate of the standard deviation is used, which is important, especially as the sample size is small.

Figure 4.1. (p.114) (adapted from Salkind, 2014) illustrates how I chose the most appropriate test for significance in this study. The t-test for independent samples determines whether there is a statistically significant difference between the mean scores of the two study groups. I chose this because the purpose of this strand of the study is to compare the differences in the OSCE scores between the graduate and experiential groups, rather than to examine any relationship between them.



**Figure 4.1. Tests for significance flow chart (from Salkind, 2014, p. 201)**



In consideration of the relatively small sample size, I used Cohen's effect size test to support the results of the t-test. Cohen's effect size test measures the effect of an intervention and does not take the sample size into account (Cohen, 1988; Coe, 2002). Cohen's effect size uses the following guidelines to assess the size of an intervention, and these are adopted in this study:

- A small effect size ranges from 0.0 to 0.2.
- A medium effect size ranges from 0.2 to 0.5.
- A large effect size ranges from 0.5 to 0.8.

Furthermore, the chi-square test was used to assess whether the OSCE scores could be expected by chance. It is necessary in this study because the sample size is not large enough to represent the larger population. As each group was tested individually, a one-sample chi-square test was used. This is also known as 'goodness of fit', because it tests how well a set of data fits with an existing set (Silverman, 2006). The OSCE scores in each category were compared with the expected OSCE scores. These were calculated by multiplying the total OSCE

scores for all categories (column total) by the total number of scores for a particular category (row total), divided by the overall total (Salkind, 2014).

The chi-square test looks at how different what is expected by chance (expected data) is from what is observed, and calculates a chi-square value. A p value is obtained and compared with the significance or confidence level, which in this study is  $p < 0.05$ . If the observed data fit with the expected data, what is observed could be expected by chance and the data sets does not differ significantly. If the observed data do not fit then what is observed is different from what is expected and is not due to chance. In other words, if a significance level of  $p < 0.05$  is used, there is less than a 5% chance that the observed scores are a result of chance and it is more likely that they are due to other influences (Salkind, 2014). Table 4.6. summarises the statistical tests performed on the quantitative data.

**Table 4.6. Summary of statistical testing**

Test	Purpose	Reason for selection
<b>Q-Q</b>	Normality of distribution	Checks distributional assumption
<b>Levene's</b>	Similarity of variance	Checks that variances between groups are statistically similar
<b>Two-tailed t-test</b>	Significance	Tests whether there is a statistically significant difference in the OSCE scores
<b>Cohen's effect size</b>	Effect size	Tests the effect size with a small sample size
<b>Chi-square</b>	Significance	Tests whether the recorded data fit with expected data

## 4.4. QUALITATIVE METHOD

The aim of the professional, qualitative strand of this research is to address the following question:

*What are the professional benefits of, and barriers to, early specialisation in MRI?*

To do this it was necessary to assess the perspectives of a variety of different stakeholders. The literature reveals that there are several benefits associated with specialist practice, including in-depth knowledge and expertise in a discrete area of practice, increased professional recognition and increased job satisfaction (White and McKay, 2004). However, significant barriers are also reported. These include exclusiveness, restricted scope of practice and fragmentation of the profession (White and McKay, 2004; Ferris, 2009). Furthermore, in the radiography profession early specialisation without the need to first qualify as a radiographer introduces additional concerns surrounding registration.

### 4.4.1. Sampling strategy

In qualitative research, where the purpose is to gain depth of understanding, the researcher needs to select 'information-rich participants from whom one can learn a great deal about issues of central importance to the purpose of the research' (Patton, 2002, p. 230). There is a wide variety in sampling typologies in qualitative research, but choices made about sampling strategy are situated in the purpose of the research and its context. As the qualitative research question reflects the need to explore a variety of viewpoints, it was necessary to select participants who were the most likely to offer different perspectives. Thus, participants who were representative of a range of perspectives were purposively sampled. Each had clearly defined characteristics, which are described later and which represent the main types of stakeholders in MRI professional practice.

### 4.4.2. Recruitment

Eight participants (n=8) were recruited to the professional, qualitative strand of this study. It was important to select participants who were likely to have a range of viewpoints on the professional impact of direct entry into MRI practice. Participants

were selected because they had experience of graduate or experiential practice, because they recruited graduate and experiential practitioners, or because they were influential in developing professional and educational policy in this area. It was important to examine the views of stakeholders in the USA, where the intervention of a specialised undergraduate degree has already occurred, and to capture some UK perspectives so that the feasibility of introducing direct entry into MRI practice in this country could be explored.

Most of the participants were purposefully sampled. The graduate and experiential practitioner participants were randomly selected from those that indicated on the consent form that they would be willing to participate in both strands of the study. The participant profiles are summarised in Table 4.7. (p.119).

***One academic (n=1, termed AC)*** was one of the gatekeepers who was used to select participants for the quantitative strand of the study. She was the programme lead for an undergraduate programme in MRI in the USA. Her background was in nuclear medicine, where she worked as a technologist. She progressed into MRI directly from nuclear medicine and ran one of the first MRI scanners in the region. She has a master's degree in human resources. She was selected for interview mainly because of her insights into how bachelor's curricula in MRI were developed and how systems are used to recruit and monitor students.

***Two clinical managers of MRI departments (n=2)*** were selected: one from the UK and another from the USA. The UK clinical manager (termed CMUK) was a diagnostic radiographer who qualified with a Diploma of the College of Radiographers over 20 years ago. She was in a managing role in a large multi-modality practice run by a national UK charity, where MRI scans are undertaken on behalf of the NHS and the private sector. The practice includes several MRI scanners and many other types of imaging. She was responsible for recruiting and managing all of the staff in the department, which, at the time of the data collection, included 23 experiential practitioners. She was selected for interview because she had learned MRI experientially and because she could provide a UK perspective. In addition, the department she managed is one of a few that employs individuals called assistant practitioners. These are practitioners who do not have a radiographic background but have gained a foundation certificate in MRI. She was, therefore, able to provide a perspective on how non-radiographic MRI practitioners integrate into a clinical department in the UK.

The clinical manager in the USA (termed CMUSA) was a diagnostic radiographer (called a radiologic technologist (RT) in the USA). She had experience in many modalities, including MRI and CT, but was in a purely managerial role when she participated in the study. She learned MRI experientially. She managed a large department, which includes many types of imaging and employs graduate and experiential practitioners in MRI. Her department was one of the clinical sites for students undertaking an undergraduate degree in MRI at a local college and for students from other imaging courses at the same institution. She was selected for interview because she had direct experience of employing graduate and experiential practitioners and could provide an insight into the benefits and drawbacks to her department of employing graduate practitioners.

***Two experiential practitioners from the USA (termed EXP1 and EXP2) (n=2)***

were randomly selected from the group of MRI practitioners who consented to participate in the quantitative and qualitative strands of my research. The first experiential practitioner (termed EXP1) was a qualified diagnostic radiographer. At the time of the data collection, he was the lead MRI practitioner in a large multi-modality department in the USA. His role mainly involved the efficient running of the MRI department and he provided a link between the clinical department and the local college, which delivers an undergraduate programme in MRI. He had direct experience of overseeing undergraduates during their clinical placement and of working with graduate and experiential practitioners who work alongside each other in the same department.

The second experiential practitioner (termed EXP2) trained as a nuclear medicine technologist in Australia and progressed into MRI after moving to the USA. He learned MRI experientially and he worked in a variety of roles within MRI. At the time of the data collection, he was what is known locally as a 'Tech 2' (someone who performs clinical examinations, rather than a student (Tech 1) or a teacher (Tech 3)) in a large multi-modality department in a teaching hospital in the USA. He was progressing into a role that involved more teaching. Unusually, he was an experiential practitioner who did not have a radiographic background; therefore, he provided a different perspective from the first experiential practitioner. He also had direct experience of graduate and experiential practitioners who work alongside each other in the same department, and he had exposure to undergraduates in clinical practice.

***Two graduate practitioners from the USA (termed GRAD1 and GRAD2) (n=2)***

were randomly selected from the group of MRI practitioners who consented to participate in the quantitative and qualitative strands of my research. The first graduate practitioner (termed GRAD1) graduated with a degree in MRI from a college in the USA. At the time of the interview, she had been qualified and working as a graduate MRI practitioner in the USA for six months. She undertook a wide variety of MRI clinical examinations without supervision. She is a typical graduate practitioner; therefore, she could provide a very personal insight into direct entry into the MRI profession.

The second graduate practitioner (termed GRAD2) also graduated with a degree in MRI from a college in the USA. He had been a primary-school teacher before joining the MRI undergraduate programme. At the time of the interview, he had been a graduate practitioner for four years and was working in a large teaching hospital in the USA. He undertook a wide range of clinical MRI examinations without supervision, including specialist examinations. He worked in the same department as the second experiential practitioner and at the same grade (Tech 2), indicating that he had a similar role and level of responsibility. He had been a graduate practitioner for several years and came from an entirely non-clinical background.

***A representative of a radiographic professional body in the UK (termed COR) (n=1)*** was purposively selected for interview because of her insight into the UK radiographic professional body's professional policies on registration and specialist practice. She was qualified as a diagnostic and therapeutic radiographer, but her responses reflected the views of the professional body rather than her own views.

**Table 4.7. Participant profile: qualitative, professional strand**

Semi-structured interviews	Graduate practitioner	Experiential practitioner	Clinical manager	Professional body rep.	Academic
n=8	2	2	2	1	1

Every participant was given the same participant information sheet and consent form that was given to the participants in the quantitative, professional strand of the

study (see Appendices 1 and 2). The consent form required participants to tick a box confirming that they agreed to participate in a semi-structured interview and that they agreed to audio recording.

#### **4.4.3. Sample size**

Eight (n=8) stakeholders were drawn from five different categories of stakeholder (graduate and experiential practitioner, clinical manager, academic and professional body representative). Determining an appropriate sample size is difficult in qualitative research, because there is no universal standard (Mears, 2012). Qualitative research traditionally relies on rich data collected from a small number of participants (Silverman, 2010). Although large sample sizes address problems of representativeness, they raise a variety of issues in qualitative research. For example, there may not be time for adequate data collection and in-depth data analysis, and individual differences in experience might be difficult to find (Creswell and Plano Clark, 2011). Mears (2012) posits that a common sample size in qualitative research is six to eight participants, especially when interviews are the research method of choice. As such, a sample size of eight seems reasonable. It was important to draw on as many different perspectives as possible to achieve a richness and variety of data and an in-depth exploration of the issues, but it was also important to balance this with what was feasible.

Although there may have been merit in interviewing other stakeholders, such as an NHS clinical manager in the UK or a representative from the radiographic professional body in the USA, a significantly larger amount of data would have been generated and this might have made the entire study unmanageable. My defence of the small sample size in this strand of the study is strengthened by Creswell and Plano Clark (2011), who suggest that in the convergent mixed-methodology design it is a good idea to have a much smaller qualitative sample than the quantitative sample. This disparity enables in-depth qualitative exploration and a rigorous quantitative investigation of the same phenomenon. It also raises questions about how to merge the data accurately when the sample sizes are different. This concern is addressed in Section 4.6.

#### 4.4.4. Methods

Semi-structured interviews were chosen as the qualitative method in this research. Although observation is a popular tool for collecting qualitative data, it is most relevant in ethnographic research, where the observation of behaviours over a long period is required (Punch, 2009). This method was discounted, because the purpose of this strand of the study is to capture opinions rather than behaviours. According to Punch (2009), interviews are the predominant qualitative method because they are the best way of understanding people's perceptions. By asking questions and receiving answers, the researcher can make inferences about the respondent's interpretation of their reality and the meaning that they place on it.

There are many different types of interview, with variables that include the grouping of respondents, the media used, the purpose and the structure. With so much flexibility, the type of interview should align with the research question that the interview is attempting to address. Punch (2009) describes a continuum model for interviews. At one end of the spectrum are structured, standardised interviews, where questions are planned within pre-coded categories and no attempt is made to go into any depth. At the other end are unstructured, open-ended interviews, where follow-up questions unfold and there are no pre-established categories. In the middle are semi-structured interviews, in which some questions are planned to ensure that the key themes are addressed but there is also some flexibility for acquiring richer data that are specific to each individual (Punch, 2009).

My field of enquiry is not limitless, so it seemed appropriate to impose some structure. Pre-defined standardised questions were necessary to ensure that the main themes, identified as important by the literature, were addressed. However, it was also important to ensure that there was sufficient flexibility to capture different or more complex professional viewpoints from each of the stakeholders. Therefore, semi-structured interviews were chosen for this strand of the study.

##### 4.4.4.1. Semi-structured interviews

According to Mears (2012), interviews are the best way to learn about the qualities of experience and to clarify or triangulate other data. Interviews are defined as 'purposeful interactions' (Mears, 2012, p. 170) that enable the researcher to



discover what someone knows, thinks or has experienced in relation to a topic. It requires that the researcher is interested in understanding the experience of other people and the meaning that they place on it (Sideman, 2006). To explore the benefits and barriers posed by early specialisation, it was necessary to select participants and design interview questions that would enable me to draw on the lived experiences of those who have a stake in this intervention.

A well-planned interview format ensures that all topics are covered, but careful consideration of the balance between structure and openness is required. In a very structured format, the same wording and order of questions is used with each participant. This type of questioning is common in surveys and it was useful in my research in terms of exploring common themes that were relevant to each stakeholder. However, a more open format allowed participants to describe their opinions, thoughts and experiences on early specialisation in MRI.

The themes I wanted to explore emerged from the literature and are summarised in Table 5.20. in Chapter 5 (shaded orange in this table). The two participants in the UK were interviewed first and the remaining six were interviewed during my visit to the USA. Each interview began with me explaining the study and the purpose and intent of the interview. The interviews were conducted in a quiet room, and only the participant and I were present. The voices of each interviewee were recorded using software for Apple iPhone and iPad called ALON Dictaphone (ALON Software Ltd). The software permitted high-quality digital recording and the files were automatically saved. An iPhone and an iPad (Apple Inc.) were used simultaneously to record each interview in case one device failed.

Each participant was asked between 12 and 20 questions over a period of 30 to 45 minutes. During the interview, topics common to every participant were first explored. Then, by inviting participants to tell me more, I was able to draw out their opinions, thoughts and experiences that specifically relate to their stake in MRI practice. This approach is supported by Morrissey (1987), who suggests that a researcher ask questions in a way that first sets context and then opens avenues for a response. The researcher responds by listening carefully and perhaps asking more probing questions based on the interviewee's response.

The interview questions and transcripts are provided in Appendices 6 and 7. Firstly, participants were asked to provide details about their background and their current

role, which set the scene for their unique perspective on the topic. A topic explored with all participants was their views on specialism; particularly, how it is defined in imaging. All participants were also asked about their perception of the benefits of, and barriers to, practising MRI without first qualifying as a radiographer. Care was taken not to specifically ask the professional, qualitative research question but to ask questions that surround these issues, such as employability and level of expertise. Silverman (2010) warns against asking participants the research question directly, as this can affect their responses.

After exploring these common topics, each stakeholder was asked specific questions relating to their unique perspective. The graduate and experiential practitioners were asked specific questions about their scope of practice, registration and job satisfaction. The clinical managers were asked questions about how well non-radiographic MRI practitioners fit into their organisation and their employability and professional values. The academic was questioned specifically about undergraduate attitudes to learning and problems with integration into clinical settings. Finally, the representative of the UK professional body was asked about the impact that early specialisation might have on the radiographic profession in the UK, registration issues, and what skills the professional body considers core to radiography.

The interviews enabled me to gain a variety of insights into the professional benefits of and barriers to early specialisation. I learned that interviews can be very unpredictable in that it is not possible to know exactly where answers will lead. It was necessary to listen carefully to the responses and look for markers that pointed to other areas to explore. I realised that I had to repeatedly confirm my understanding of what I was hearing by checking it with the respondent. Furthermore, I was conscious of the need to refrain from making any judgement during the interviews or imposing my opinions on the participants (see Section 4.5.).

Ideally, I should have piloted the interview questions with a focus group (Silverman, 2010). This might have helped to clarify the main themes of the interview, but there was insufficient time to do this before the data collection began. However, I piloted the questions on a non-research participant (who is an experiential practitioner and a clinical manager) *a priori* to ensure that they were worded clearly and could capture the information needed to address the professional, qualitative research

question. In addition, the questions were reviewed for openness and clarity by an individual who teaches interview-questioning techniques. During the interview process, I found that my interview skills developed and were refined by learning from issues that arose from the earlier interviews. These mainly focused on the best ways to encourage communication and re-focus responses on the topic.

Interviews are spaces in which the researcher and the participant are both engaged in collaborating, making meaning and producing knowledge (Silverman, 2006). I am aware that in choosing specific types of stakeholder and linking these to different themes that I wished to explore, I was making specific analytical choices about what types of people and voices are central to my research and who remains silent. However, the themes I have identified are embedded in previous research on specialist practice and they have guided my choice of stakeholder. I am confident that the right type and number of stakeholders were recruited to this strand of the study and that their transcripts are an accurate reflection of what was said during each interview.

## 4.5. QUALITATIVE ANALYSIS

The purpose of analysing the qualitative data is to explore the professional benefits of, and barriers to, early specialisation in MRI. Transcripts were made of all the interviews after I returned from the USA. This was performed by a professional transcriber using the audio files and saved into a word-processing software package. Some researchers advocate transcribing each interview before conducting the next so that the interview notes and the transcript can be reviewed together to prepare for the next interview (Mears, 2012; Silverman, 2010). This was not possible, because most of the interviews were conducted in the USA within a short time frame. However, after the transcription was complete I was able to cross-reference each transcript with its audio file to ensure clarity and accuracy.

NVivo for Mac (version 10.2.2) was used to code the transcripts of all eight interviews. Codes are tags that are used to label either words or chunks of text. The purpose is initially to index the data and then, by attaching meaning to them, to allow further coding. In turn, this coding process summarises the data by drawing them together into different patterns. In this way, links between concepts and ideas can be made (Punch, 2009). The coding was initially organised around the themes identified by the literature that was reviewed at the beginning of the research process. This was performed across all the interview transcripts. After carrying out further detailed discursive analysis of text that was linked to the parent nodes, sub-themes began to emerge. These were coded as child nodes. The child nodes represented a higher level of abstraction and were more interpretative and inferential than the parent nodes. They enabled me to see connections, contradictions and commonalities amongst the data and, consequently, uncover additional insights into the professional benefits of, and barriers to, early specialisation. The coded parent and child nodes with the number of sources and references are shown in Table 5.20. in Chapter 5 (p.168). The parent nodes, which are based on themes that emerged from a preliminary review of the literature, are shaded orange, and the child nodes, which emerged from further coding of the interview transcripts, are shaded white (see Table 5.20. p.168).

### 4.5.1. Design considerations

Issues such as credibility and transferability are evaluated in the light of the findings of this study in Section 6.6. At this stage, it is important to consider the overall design of this strand of the study and examine potential limitations and pitfalls. A characteristic of qualitative research that sharply contrasts with quantitative research is its diversity. Denzin and Lincoln (1994) define qualitative research as 'a series of tensions, contradictions and hesitations' (p. ix). Qualitative research, therefore, is not a single entity but an umbrella term that covers enormous variability (Punch, 2009). It is epistemologically multi-dimensional and pluralistic in its approach and has common themes that distinguish it from quantitative research.

Qualitative research involves studying people and events in their natural settings. Its method deals with participants rather than variables. It is good for finding specific patterns amongst a small set of individuals, although its findings are particular to these individuals and are not necessarily transferable (Punch, 2009). Qualitative research is sensitive to context and lived experience and the researcher is inside what is being researched. Its purpose is to understand a phenomenon holistically and in depth. Samples are usually small and sampling strategies are guided by theoretical considerations rather than problems. Qualitative design is more diverse and less replicable than quantitative research, but it is more flexible (Denzin and Lincoln, 1994). An important strength of qualitative research is that it is the best way of getting an insider perspective of a phenomenon and exploring the meanings that people attach to things (Miles and Huberman, 1994). Therefore, it can be used to study the lived experiences of people and address complex phenomena.

The characteristics of each stakeholder are described in Section 4.4.2. Each is unique in the sense that each was able to provide a particular perspective on the problem. For example, the representative of the UK professional body spoke for the professional policy of that institution. Her data provided a political and professional perspective. This compares with the academic participant, from whom an educational viewpoint was gained, and the experiential and graduate practitioners and clinical managers, who provided clinical, educational and professional angles. Thus, a range of perspectives was expected in the qualitative data. The interview questions were designed to capture these and were based on themes that

emerged from the literature review. The analysis of the interview transcripts involved assembling and organising the data and then looking for patterns to learn more about the research problem.

One of the criticisms levelled at this approach concerns transferability. Is it possible to generalise these data from only a few participants? Denzin (1983) argues that if the opinions of an individual are uniquely interesting or different then transferability is not important. Punch (2009) rejects the notion that this type of data can never be generalised. He posits that this approach can be used to conceptualise or develop propositions; therefore, it can be put forward as applicable to other situations. It is necessary to focus on common elements and use a high level of abstraction during the analysis phase. This lifts it above simple description and produces transferable findings and propositions that can be tested by further research. The propositional approach seems to be relevant to my research, because I might be able to forward a hypothesis that links the viewpoints of each participant. The hypothesis can then be assessed for applicability and transferability to other situations. A relatively small number of stakeholders were included and most of them related specifically to education and practice in the USA. Although in many respects every participant was unique, some were also similar. For example, although the educational culture is different, MRI clinical practice is similar in the USA and UK; therefore, the competencies required of an MRI practitioner in these two countries are broadly the same. Consequently, the knowledge required by a competent practitioner is comparable, so educational methods are theoretically transferable.

Achieving replicability in qualitative research refers to transparency. According to Mears (2012), this is achieved by providing a thorough and accountable audit trail of research procedures so that others may follow or develop your study. In qualitative research, reliability refers to 'the trustworthiness of observations or data' (Stiles, 1993, p. 601). It is measured by the degree to which the data reflect the participant's authority to comment on what is being studied and the meaning the participant attaches to it. Therefore, it is essential that the correct participants are selected and that the accuracy of their responses is checked. I am confident that the sampling method used in this strand of the study has enabled me to select the most appropriate stakeholders to comment on the benefits of, and barriers to, early specialisation. They are mainly people who have either specialised in MRI without first qualifying as a radiographer or who have experience of educating, recruiting or working with these individuals. In addition, I maintained a meticulous and

transparent audit trail, which includes details about the interview questions and the interview responses described in the transcripts. I also kept records on my thoughts and processes during the thematic coding of the qualitative data.

The accuracy of responses was verified after transcription by 'checking back in' with each respondent and asking each to confirm that the transcript was an accurate representation of what they had said during the interview. All of the participants verified that their transcripts were a truthful portrayal of the issues covered during the interview. This type of checking is an important way of increasing the internal validity of qualitative research (Punch, 2009). However, its use and limitations need to be scrutinised to ensure that the level of checking is appropriate for the type of research. For example, participants may be asked to verify the interview transcripts only or they may also be involved in checking the validity of any emergent findings. Although the latter approach might increase internal validity in certain types of research, there is a danger that the participants might influence the researcher's analysis of the data (Punch, 2009). The former method was adopted in this study, so the participants could not have impacted upon the analytical process. However, I recognise that had respondents been asked to check the findings, further insights and abstractions might have been possible.

An important consideration that affects the quality of qualitative research is the extent to which the pre-formed opinions of the researcher or the participants may have tarnished the truthfulness or credibility of the research. As a novice qualitative researcher at the beginning of this process, I have given a lot of consideration to this aspect of my research. I am aware that I bring a theory to this research: that early specialisation via an undergraduate degree might be a better way of educating MRI practitioners. However, it was important that participants were not conscious of this and, therefore, that they were not influenced by it. To minimise bias, the interview questions were as open-ended as possible and I took care in the phrasing of follow-up questions. I found this aspect of the interviews particularly difficult. Respondents sometimes wandered off the topic and it was necessary to re-focus their thoughts on the themes I wanted to explore. It was sometimes difficult to do this in a way that was not influenced by my perspective on the topic.

Qualitative research is subjective by its very nature; however, according to Silverman (2006), subjectivity has its virtues and good researchers can legitimately

use their pre-existing knowledge to good advantage. The real aim is to 'reveal the sources of bias rather than pretend they can be nullified' (Thompson, 2000, p. 137). Therefore, I have disclosed aspects of the qualitative design that could have subjectively affected the findings and explained the measures that I took to limit bias. An important reflection is my positionality as an insider-researcher. This 'insideness' stems from the fact that I am well known in MRI circles. It might have set up intimidatory influences that caused respondents to provide answers they thought I wanted to hear, rather than those that accurately reflected their opinions. According to Mears (2012), it is not possible to remove these influences completely. The best a researcher can do is to consider how participants might respond and attend to perceptions that might negatively affect the research. During the interview process, I constantly monitored assumptions and refrained from taking what I heard for granted. I took the time to build a rapport with each participant and to develop my comprehension of what each participant was saying. In this way, I believe that I have applied the principles of good qualitative research.



## 4.6. MERGING THE DATA

### 4.6.1. Merging strategies

After analysing the quantitative and qualitative data, mixed-methodology researchers go one step further by looking across both sets of data and assessing how the information addresses the mixed-methodology question (Creswell and Plano Clark, 2011). Inferences are drawn from the quantitative and qualitative data separately, in addition to across both strands. This is considered as a way of improving the quality of corollaries that are drawn from either strand on its own (Tashakkori and Teddlie, 2010).

The aim of combining the qualitative and quantitative data is to address the following mixed-methodology question:

*To what extent do the educational and professional perspectives explored in this study support the introduction of a specialised undergraduate degree programme in MRI?*

To achieve this goal, it was necessary to merge the data and make connections between them so that a picture could be drawn that pulls together the educational and professional aspects of this topic. In this way, I synthesised both types of data to examine whether the educational and professional perspectives explored by this research support the introduction of a specialised undergraduate degree in MRI. To facilitate this, I constructed a method of merging the data that allowed me to see the congruencies and discrepancies between them clearly. By doing so, I was able to explore to what extent the quantitative and qualitative findings converge.

A very important element of my research, therefore, is the convincing integration and interpretation of both types of data. The first step was to decide on the most appropriate and robust way of merging the data. Creswell et al. (2003) draw attention to the fact that there is little consensus on how best to do this and Creswell and Plano Clark (2011) report that there is an on-going debate in the mixed-methodology research community on different integration typologies. Specific approaches have been advocated (O'Cathain, Murphy and Nicholl, 2010), but Bazeley (2009) provides a comprehensive framework of the steps and

decisions needed to ensure that the type of mixed-methodology design is congruent with the correct data-merging method. According to this framework, the convergent nested design used in this study involves several decision strategies. These include specifying the dimensions by which the two sets of results are compared, refining both sets of data to produce the comparison information, representing those comparisons and, finally, interpreting how the combined results answer the research question (Bazeley, 2009).

Creswell and Plano Clark (2011) suggest several strategies for comparing results using tables. These are side-by-side comparisons, category-versus-theme displays, and typology and statistics merged displays. However, the format that is best suited to my purpose is a convergent and divergent display. This enables me to analyse quantitative and qualitative data, compare the results and create a table to display the congruent and discrepant findings (Creswell and Plano Clark, 2011). Feters, Curry and Creswell (2013) advocate the use of a matrix that places importance on connections between the data, rather than on the data itself. This illuminates findings that otherwise might have been hidden and reduces the relevance of traditional quantitative limitations, such as sample size. Table 4.8. (p.132) illustrates how this format fits with my research questions. It is a connections matrix, which allows me to find links between the educational, quantitative findings and the professional, qualitative findings and see where they agree or disagree. In turn, this enables me to make inferences on whether the introduction of a specialised undergraduate degree is a better way of educating MRI practitioners than the experiential method is.

Table 4.8. (p.132) illustrates the dominance of the educational strand of this study. The issue of whether it is necessary to first qualify as a radiographer is an important aspect of the professional strand of this study, as this has implications for the radiographic profession. However, if the educational strand yields data showing that there are significant educational benefits of introducing a specialised MRI undergraduate degree without the need to first qualify as a radiographer then this is more important, because it relates to competency and patient safety.

**Table 4.8. Connections matrix**

RESEARCH QUESTION	QUANTITATIVE	QUALITATIVE	INTEGRATION	POSSIBLE CONCLUSION
How do we best educate MRI practitioners?	What is the relationship between the way in which a practitioner learns MRI and their knowledge of MRI theory?	What are the professional benefits of, and barriers to, early specialisation in MRI?	To what extent do the educational and professional perspectives explored in this study support the introduction of a specialised undergraduate degree programme in MRI?	
	grad score > exp score	benefits > barriers	CONFIRMATION	Undergraduate degree in MRI is the best way to educate practitioners.
	grad score < exp score	benefits < barriers	CONFIRMATION	Undergraduate degree in MRI is not the best way to educate practitioners.
	grad score > exp score	benefits < barriers	DISCORDANCE	Undergraduate degree in MRI is the best way to educate practitioners, but there are significant professional barriers.
	grad score < exp score	benefits > barriers	DISCORDANCE	Undergraduate degree in MRI is not the best way to educate practitioners, despite professional benefits.
	grad score = exp score	benefits > barriers benefits < barriers benefits = barriers	EXPANSION	Undergraduate degree in MRI may be the best way to educate practitioners, but further research is required.

Another aspect of Table 4.8. (p.132) is that the discrepancies are seen as a useful interpretative tool. Textbooks on mixed methodologies draw the reader's attention to the need to reconcile differences in the data. However, some researchers, such as Lee and Greene (2007), use these as a tool to interpret the combined data rather than to try to reduce them. In Table 4.8. (p.132) the discrepancies appear to be as valuable as the congruencies in addressing the mixed-methodology research question. Therefore, I have chosen to value conflicts in the data in my analysis and use these to illuminate the findings further.

#### **4.6.2. Validation of the merging method**

The act of combining quantitative and qualitative approaches in one study raises additional validity concerns, which extend beyond those that apply to quantitative or qualitative research. Creswell and Plano Clark (2011) stress the need for addressing the validity of each strand separately before the data are merged. This is why I have given detailed consideration to the validity and reliability of the quantitative and qualitative methods used in my research. However, it is also important to address potential issues surrounding the interpretations, which might compromise the mixing of data and any subsequent conclusions. These include using inadequate approaches to converge data and making illogical comparisons of the two results of analysis (Creswell and Plano Clark, 2011).

I am confident that the approach I have taken to converge the data has a sound basis, as it is a well-recognised type of merging model. It is also clear from this matrix exactly how logical interpretation across both types of data is performed and how this allows me to address the mixed-methodology research question. Data analysis is an iterative process. Findings are initially drawn from the data, but then the data are re-visited to ensure that they support the findings.

## 4.7. ETHICAL CONSIDERATIONS

My research involves human participants; therefore, it is important that the methods used adhere to strict ethical principles (Shamoo and Resnik, 2009). When a researcher sets out to learn from others, it is necessary to consider how their research affects the participants. The imperative of 'first do no harm' drives every action and decision. Respecting participants, ensuring genuine informed consent, maximising benefits and minimising harm, and ensuring fairness and equity in selecting participants are all mandates for obtaining ethical approval. However, the ethics of accuracy and principled conduct are also important. As a visitor in my participants' world, I am responsible for communicating honestly, treating them fairly and using their data as promised.

I am drawn to a metaphor used by Mears (2012) to describe the concept of separation that challenges all researchers, especially those who wish to explore lived experiences using interviews. She contests that each of us has a unique awareness and experience of events and that until these are shared, they remain within our own 'membrane of knowing' (p. 174). The interview provides a way for the researcher to cross this membrane and journey into another person's perspective of an event. Consequently, understanding of the event is shared and leads to new discoveries. This metaphor, I believe, emphasises the privileged position of the researcher. As a visitor in the participants' world, the researcher is responsible for conducting the study in a way that is as fair and as ethically sound as possible.

During the design phase of my research, consideration was given to the best way of obtaining ethical approval at my institution and at sites in the USA. As the data were primarily collected at four HEIs in USA, it was necessary to comply with the ethical guidelines of these institutions in addition to those of Anglia Ruskin University. Fortunately, my research was exempt from the requirement for full ethical approval in the USA, because it involved only educational tests and interviews with de-identified participants. Every HEI required that approval was first obtained from Anglia Ruskin University and, once that had been granted, the approval process merely involved sending the gatekeeper at the four clinical sites in the USA the letter of approval from the Anglia Ruskin University Ethics Committee.

Gatekeepers at all four HEIs were used to gain access to the participants in the USA. They were all directors of the MRI undergraduate programme and were all experienced researchers. Therefore, they had the knowledge and power to take on this role effectively and understood the importance of ethical research. All the participants had full autonomy in that the gatekeeper and I ensured that they had the capacity to understand and process the information given to them and had the freedom to volunteer to participate without coercion or undue influence (Belmont Report, 1979). The participation information sheet and informed consent form were developed using a template provided by the Ethics Committee at Anglia Ruskin University (see Appendix 1). All the participants were provided with these documents. The participant information sheet included information about the purpose of the study, what participants were required to do and how their confidentiality would be maintained. Each participant was required to provide informed consent to take part in the quantitative strand of the study and was asked if they would consent to participate in the qualitative strand if required (see Appendix 2).

The participation information sheet was designed to ensure that participants were aware that their inclusion in the study was entirely voluntary. I made it explicit in the instructions that participants would be anonymised and no record of their personal details would be retained; in particular, their OSCE score would never be revealed to their employer or any licensing or registration body. Two participants who had initially agreed to participate in the OSCE changed their mind when I arrived at their site and explained what was involved. Although they did not give a reason, it is possible that their withdrawal was due to fear of exposure of their lack of MRI knowledge. It is also possible that some participants felt pressured to participate because I was present. Whilst I recognise and acknowledge this, the effects appear to have been small. My presence at each clinical site might have helped in the recruitment process and resulted in a larger sample size than if I had left data collection to the gatekeepers, but I am confident that there was no coercion and that any insider influences were minimised.

The anonymity of participants was maintained by allocating each of them a random number. Only this was used for data collection and analysis. These de-identifying numbers were used for all data collection from each participant in the quantitative strand of this study, and no records were kept that would link the number to the

participants' personal details. I have retained the OSCE test sheets, but these will be destroyed at the end of this research. No personal records were kept on the qualitative sample. The audio recordings will also be deleted at the end of this research.

In the semi-structured interviews, consideration was given to the possibility that the independence of the participants might be compromised because of power relationship dynamics between them and me and by competing loyalties and hierarchical relationships within the workplace. I am well known in the field of MRI, so some participants might have felt intimidated. Before the interview, time was taken with each participant to establish a rapport, put them at ease and gain their trust. Dialogue with participants before the interview stressed the importance of honesty and openness and re-iterated the confidentiality of their answers.

At the beginning of this process I questioned my position with respect to my research. Am I an insider-researcher who has a place within the group I am studying, or am I not part of this group and, therefore, outside my research? (Mercer, 2007; Moore, 2012). What is my relationship with the sample, and does this enable or obscure the research process? (Kanuha, 2000). Ritchie, Zwi and Blignault (2009) suggest that there is a blurring of the apparent separation between insider and outsider positionality and that it is more appropriate to define the stance of a researcher by their physical and psychological distance than by the traditional definitions. Although none of the participants knew me on a personal level and I had not met any of them prior to the data collection, I acknowledge that I was well known to the participants on a professional level and the fact that I had travelled from the UK might also have been influential. In this respect, I recognise that I could be considered an insider-researcher, and this presented some ethical challenges. To some extent, these were mitigated by asking the gatekeepers to recruit participants, but I acknowledge that once I arrived at each site there could have been some insider influences at play. Mulhall (2003) suggests that sampling decisions are often influenced by the ease of gaining access but warns that insider-researchers should not exploit their position of power. This dilemma illustrates the conflict between the desire to fulfil the requirements of the study and the need to ensure that no coercion has taken place.

## 4.8. CONCLUSION

The chapter clearly sets out, explains and justifies the methods I have used in my research. Detailed consideration is given to the representativeness of the quantitative and qualitative samples and to the validity and reliability of the tools used to collect and analyse the data. Strategies for mixing and connecting the two types of data in this mixed-methodology study are also explained and justified. Ethical concerns are revealed and the strategies used to minimise these are explored.

In the next chapter, the quantitative and qualitative findings of my research, which result from the statistical and thematic analysis of the data, are illustrated and described using graphs, tables and explanatory text.



## CHAPTER 5: FINDINGS

## 5.1. INTRODUCTION

This chapter sets out the findings of this research. It is divided into quantitative and qualitative results. The quantitative findings are subdivided into descriptive and inferential statistics. Descriptive statistical analysis is used to describe the raw data in addition to simple characteristics of the sample groups that have been normalised to account for the difference in sample size. The descriptive statistical analysis is performed using the same spreadsheet software used to record the raw data (Apple Numbers version 3.6.3). Inferential statistical analysis is used to enable inferences about the wider population based on these sample characteristics. It is used to test the null hypothesis that graduate practitioners do not have more residual knowledge of MRI than experiential practitioners. Inferential statistical analysis is performed using specialised software that is compatible with Apple Numbers (Statistics Wizard version 1.7.9). A confidence or significance level of  $p < 0.05$  is applied to all tests.

The qualitative findings are subdivided into different themes. These themes provide a synthesis the eight stakeholders' responses to questions relating to the perceived professional barriers and benefits of introducing a specialised undergraduate degree in MRI. Six general themes were identified by the literature; these were used to code eight interview transcripts using NVivo for Mac (version 10.2.2). Further detailed coding identified sub-themes (or child nodes), and these are illustrated in Figure 5.17 (p.167). The parent and child nodes, with the number of sources and references, are shown in Table 5.20 (p.168). The discussion provides a discourse on the emergent themes into which are woven individual responses. Specific excerpts from the transcripts are provided in tables; words in italics and brackets indicate the context of the comment. The quantitative and qualitative findings are then integrated in Chapter 6.

## 5.2. QUANTITATIVE FINDINGS

### 5.2.1. Descriptive statistics

The following descriptive statistics are illustrated using figures and tables. Firstly, the raw data OSCE scores are shown. These raw data are not comparative, because the sample sizes are different (graduate  $n=25$ , experiential  $n=23$ ). They are used to illustrate the general trend of scores across the five sections of the OSCE for both groups in terms of correct answers, incorrect answers and questions for which no answer was volunteered. Participants were asked to leave a question blank if they could not volunteer an answer (did not answer – DNA) in an attempt to eliminate a question being answered correctly by chance (i.e. guessing the answer). The highest and lowest individual total scores within each group, and the difference between the highest and lowest individual scores for each section, are also provided. After this, raw data that have been normalised to account for the difference in sample size are presented. These data are used to make comparisons between each group in terms of the mean, median, mode, standard deviation and variance. They are also used to compare each section of the OSCE in terms of the number of questions that participants did not answer.

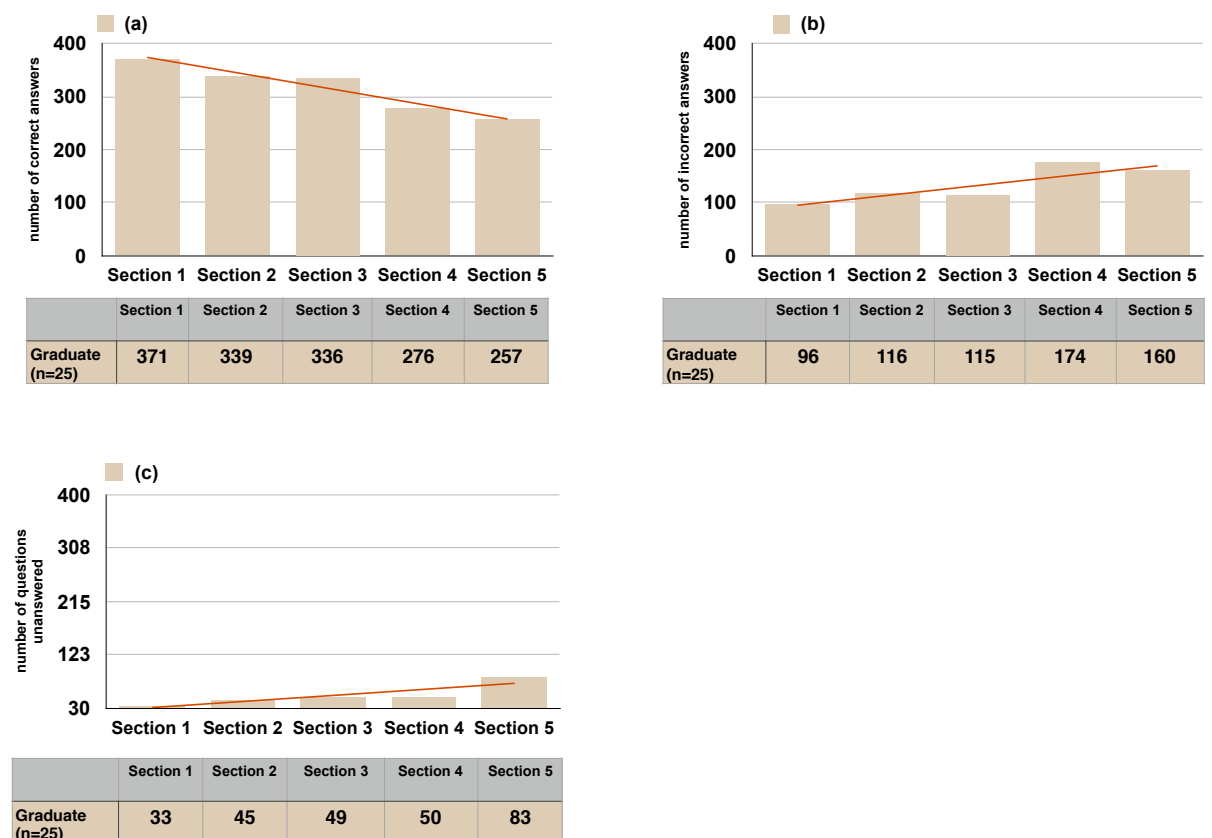
### 5.2.1.1. Raw data

#### OSCE scores

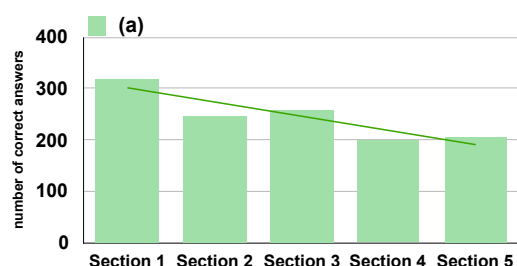
The trend in OSCE scores from Section 1 to 5 of the OSCE are shown in Figures 5.1 and 5.2. Figure 5.1 illustrates the trend for all correct answers (a), incorrect answers (b) and questions not answered (DNA) (c) for the graduate practitioner group. Figure 5.2 (p.142) illustrates the same data for the same categories in the experiential practitioner group.

N.B. It is important to note that these graphs are not directly comparable because of the different sample sizes (graduate n=25, experiential n=23).

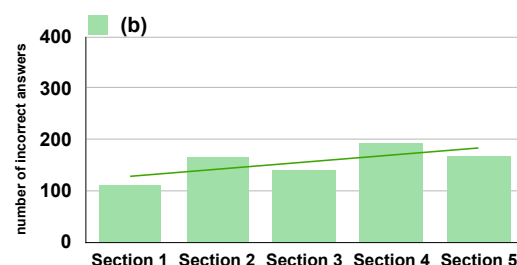
**Figure 5.1. Trend in graduate OSCE scores (a) correct answers, (b) incorrect answers, (c) questions not answered (DNA).**



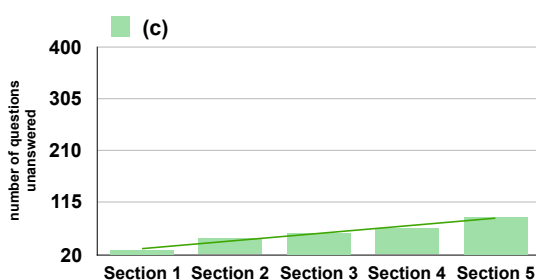
**Figure 5.2. Trend in experiential OSCE scores (a) correct answers, (b) incorrect answers, (c) questions not answered (DNA).**



	Section 1	Section 2	Section 3	Section 4	Section 5
Experiential (n=23)	319	247	260	200	204



	Section 1	Section 2	Section 3	Section 4	Section 5
Experiential (n=23)	112	165	140	193	167



	Section 1	Section 2	Section 3	Section 4	Section 5
Experiential (n=23)	29	48	60	67	89

The total OSCE scores show a similar trend in both groups. In general, the total scores for the graduate and experiential groups decrease from Section 1 to Section 5. Section 1 (MRI safety, anatomy and pathology) scores the highest in both groups, whereas Section 4 (image production) and Section 5 (image optimisation) are the two worst-scoring sections in both groups (Figures 5.1(a) and 5.2(a)). The total number of incorrect answers shows a similar trend in both groups. Fewer questions are answered incorrectly in Section 1 (MRI safety, anatomy and pathology). Most questions are answered incorrectly in Section 4 (image production) and Section 5 (image optimisation) (Figures 5.1(b) and 5.2(b)). The total number of unanswered questions shows a similar trend in both groups. For both groups, the fewest unanswered questions are in Section 1 (MRI safety, anatomy and pathology) and the most unanswered questions are in Section 5 (image optimisation) (Figures 5.1(c) and 5.2(c)).

### ***Lowest and highest individual total OSCE scores***

The highest and lowest total OSCE scores attained by an individual participant in each group are shown in Table 5.1. This table also illustrates the difference between the highest and lowest individual score in each group.

**Table 5.1. Lowest and highest total OSCE score achieved in each group**

	Lowest score	Highest score	Difference
Graduate	47	85	38
Experiential	18	87	69
Difference	29	2	-

The difference between the lowest individual total OSCE score in each group is 29% (graduate 47%, experiential 18%). However, there is only a 2% difference in the highest total OSCE score for an individual in each group (graduate 85%, experiential 87%). Therefore, the difference between the lowest and highest individual scores is higher in the experiential group (69%) than in the graduate group (38%). Consequently, when comparisons are made between the groups later in this section, the median and mode are illustrated alongside the mean for each group to provide a clearer picture of the central tendency of total OSCE scores for each group (see Table 5.2. p.147).

The lowest scores attained by an individual in each group are lower in the experiential group than in the graduate group for every section of the OSCE (Figure 5.3. p.144). The lowest score achieved by a participant in the experiential group is in Section 4 (image production). Section 4 and Section 5 (image production and image optimisation) share the lowest score achieved in the graduate group. The highest score achieved by an individual is higher in the experiential group than in the graduate group in Section 1 (MRI safety, anatomy and pathology), Section 3 (image contrast and pulse sequences) and Section 5 (image optimisation). The highest score achieved by a participant in the graduate group is in Section 4, and in the experiential group it is in Section 3 (Figure 5.4. p.144).

Figure 5.3. Lowest OSCE score achieved by an individual in each group, by section

	Section 1	Section 2	Section 3	Section 4	Section 5
Graduate	10	9	8	4	4
Experiential	6	5	4	0	2

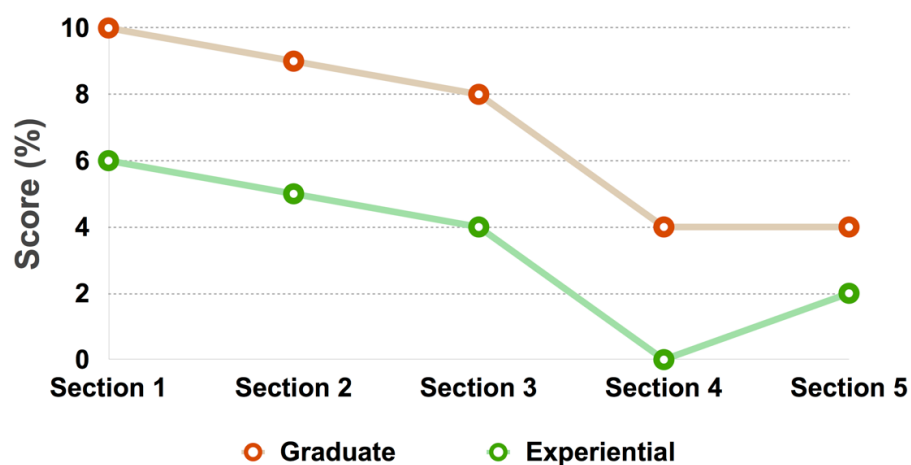
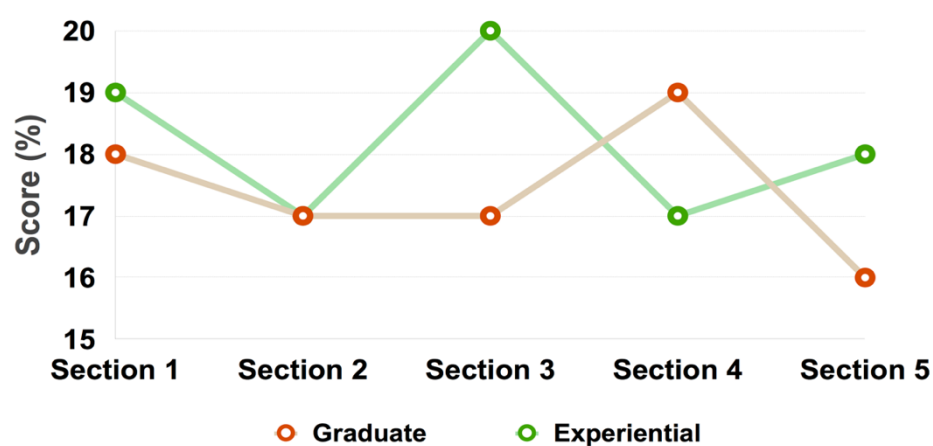


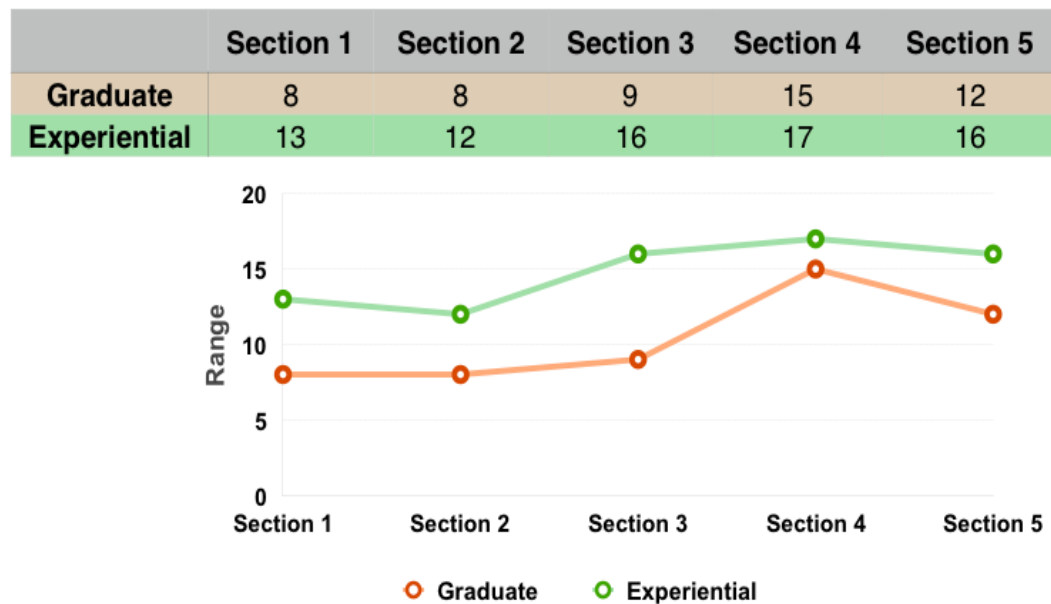
Figure 5.4. Highest OSCE score achieved by an individual in each group, by section

	Section 1	Section 2	Section 3	Section 4	Section 5
Graduate	18	17	17	19	16
Experiential	19	17	20	17	18



For all five sections, the difference between the lowest and highest individual scores is smaller in the graduate group than in the experiential group. The largest difference in both groups is in Section 4, and in the graduate group Section 5 also shows a larger difference than Sections 1, 2 and 3 (Figure 5.5.).

**Figure 5.5. Difference between lowest and highest section score achieved by an individual in each group**

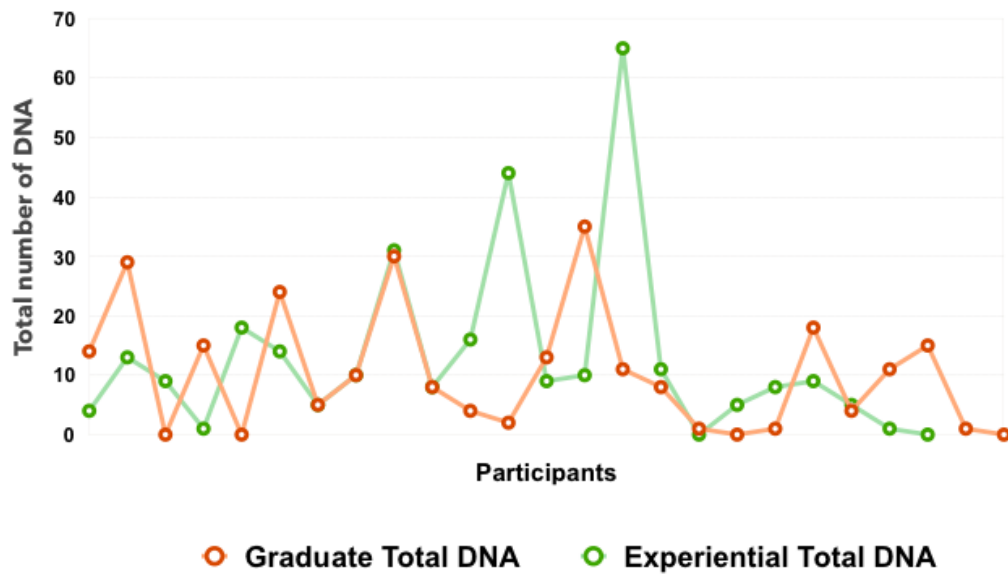


### ***Questions that participants did not answer (DNA)***

Figure 5.6. (p.146) compares the total number of questions that are left unanswered by participants in each group.



**Figure 5.6. Total number of questions not answered by each participant**



Overall, slightly more questions are left unanswered by individual graduate practitioners than by individual experiential practitioners. However, two experiential practitioners have left a significant number of questions unanswered (44/100 and 65/100 questions), whereas in the graduate group the highest number of questions left unanswered by a participant is 35/100.

#### **5.2.1.2. Comparative data**

Table 5.2. (p.147) shows the descriptive statistics when normalised to account for the difference in sample size between the two groups. These statistical characteristics use the sample size (n) and allow comparisons to be made between the two groups. Figures 5.7. to 5.9 (pp.147-149). compare the mean, standard deviation and variance for each section.

As previously described, there is a large difference between the highest and lowest individual scores between each group (graduate=38, experiential=69; see Table 5.1., p.143). The mean is sensitive to extremes in scores; therefore, the central tendency is also described using the median and mode.

**Table 5.2. Summary of raw data normalised to account for sample size difference**

	Mean	Median	Mode	SD	Variance
Graduate	63.18	62	57	11.03	121.56
Experiential	53.48	54	57	16.24	263.70

### ***Mean, median and mode***

The mode is the same in each group, illustrating that a score of 57% is the most frequently occurring total OSCE score in the graduate and experiential groups. However, the median scores are different. The midpoint of the set of scores for the graduate group is 62%, compared with 54% for the experiential group. This means that half of the participants' scores are lower than this score (either 62% or 54%), and half are higher. The difference in the median is likely to account for the difference in the mean between each group (Figure 5.8. and Table 5.2.).

**Figure 5.7. Comparison of mean scores for each section**

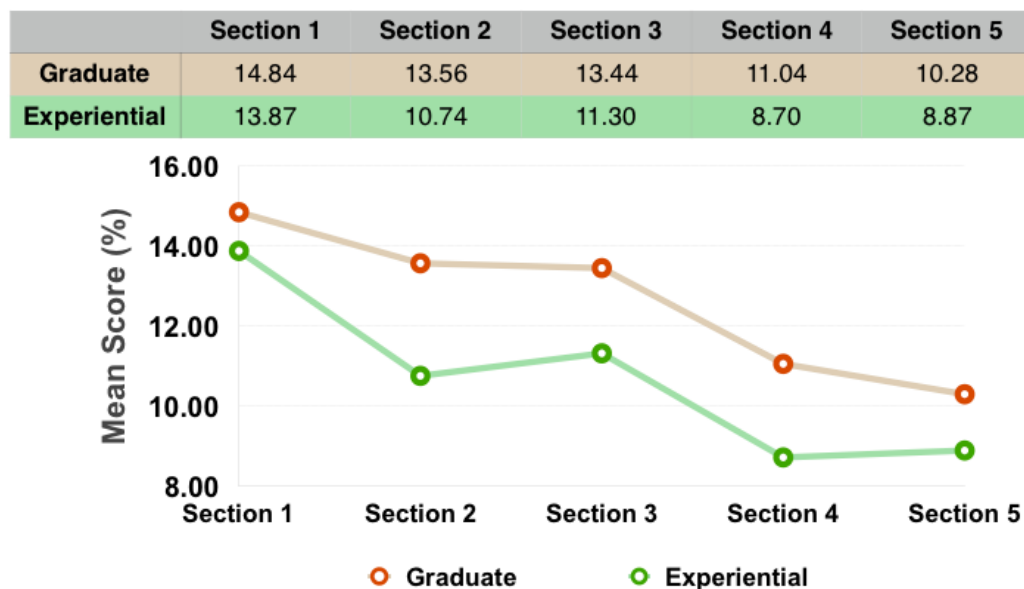


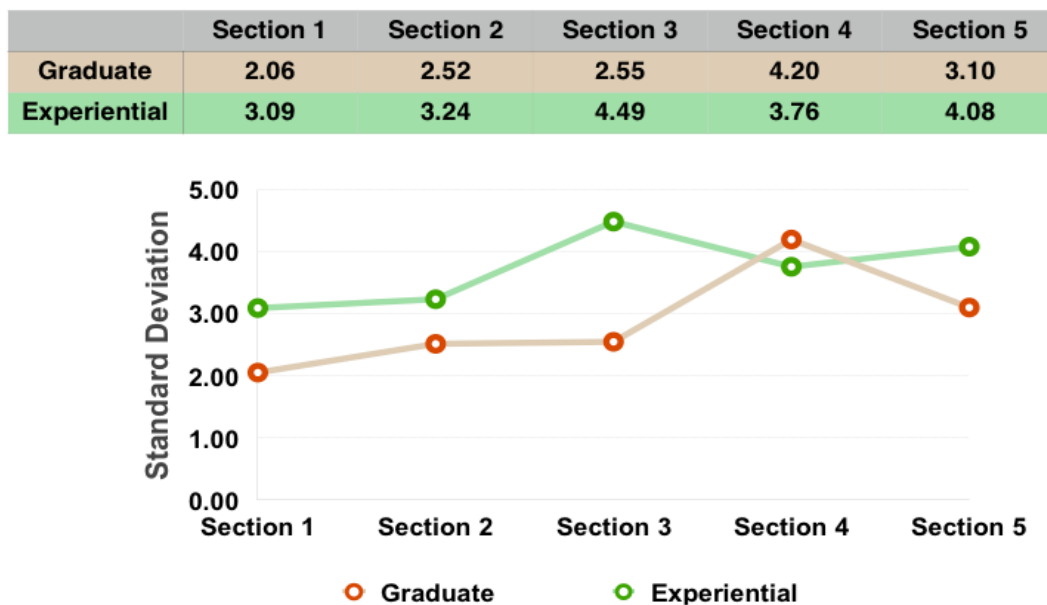
Figure 5.7. illustrates that the mean scores for the graduate group are higher than those of the experiential group in all sections. The lowest mean score in the

graduate group is in Section 5 (image optimisation) and in the experiential group it is in Section 4 (image production).

### **Standard deviation**

Figure 5.8. compares the standard deviation of each group for all five sections of the OSCE.

**Figure 5.8. Comparison of standard deviation for each section**

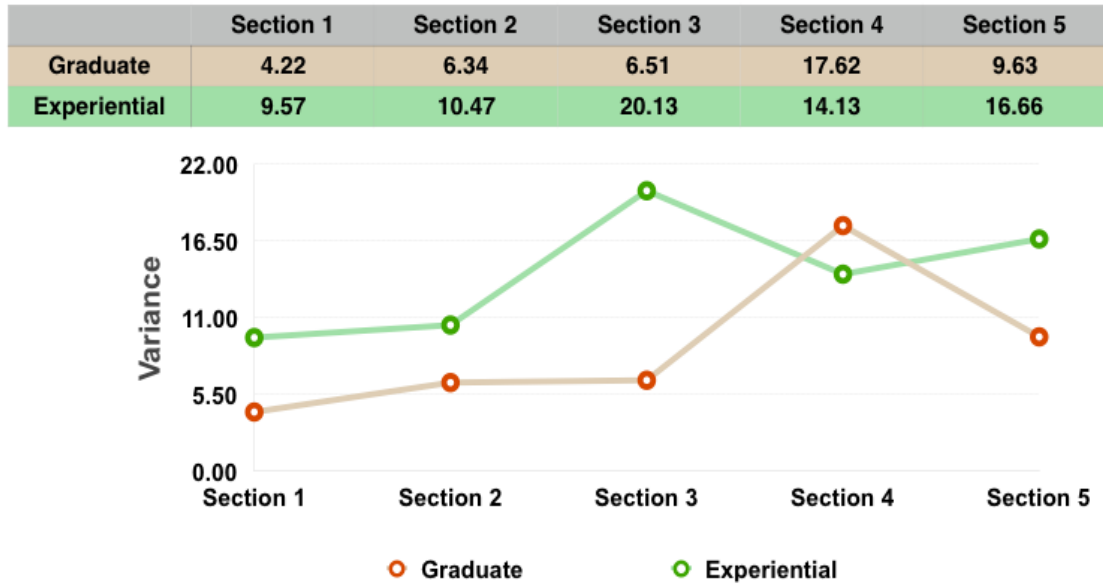


The standard deviation (SD in Table 5.2.) and variance between each group are compared in Figures 5.8. and 5.9. The standard deviation is the most frequently used indicator of variability. It represents the average amount of variability, which is the average distance from the mean, and enables an inferential comparison to be made between the scores achieved by the graduate and experiential groups. The standard deviation is lower in the graduate group than it is in the experiential group (Table 5.2., p.147). The standard deviation for each section illustrates that the standard deviation in the experiential group is higher than it is in the graduate group for all sections except Section 4 (image production), where the standard deviation in the experiential group is slightly lower than it is in the graduate group. The highest standard deviation is in Section 4 (image production) for the graduate group and in Section 3 (image contrast and pulse sequences) for the experiential group.

## Variance

Figure 5.9. compares the variance in OSCE scores for each group in all five sections of the OSCE.

**Figure 5.9. Comparison of variances**



The variances show a similar pattern to that of the standard deviation, with the highest variances in the same sections (graduate group in Section 4 and experiential group in Section 3). Variance is an important calculation, as it is used in many inferential statistical tests. Levene's test is performed to determine if the variances should be treated as statistically different for inferential testing (see Section 5.2.2.2.).

## Questions not answered (DNA)

A comparison of unanswered questions in all five sections for graduate and experiential practitioners is shown in Figures 5.10. to 5.14 (pp.150-154). These figures are calculated by dividing the total number of participants who have left a question blank by  $n$ . This calculation is necessary because the sample sizes are not equal; therefore, it is not possible to make a direct comparison between the questions left unanswered by participants in each group. For simplicity, the

percentages are rounded to the nearest whole number. The numbers of questions left blank by each group are described.

**Figure 5.10. Section 1 – Questions left unanswered (DNA), as a percentage**

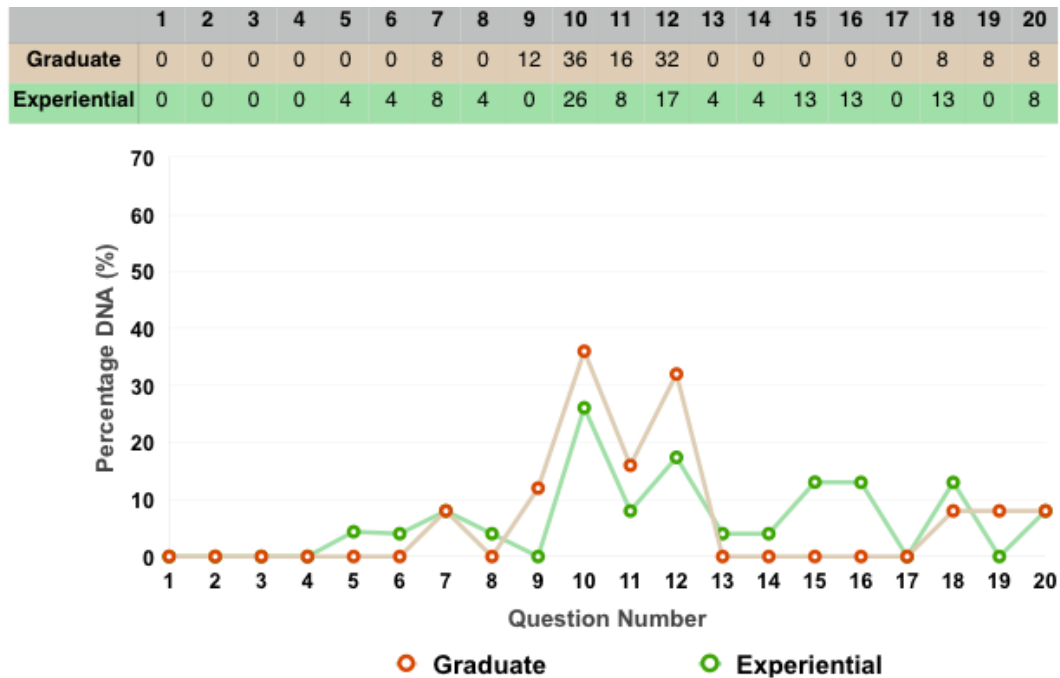


Figure 5.10. shows that out of the 20 questions in Section 1, eight (40%) are left unanswered at least once in the graduate group and seven (35%) are left unanswered at least once in the experiential group. Questions 10, 11 and 12 are not answered by more graduate than experiential practitioners, whereas questions 15, 16 and 18 are more commonly left unanswered by the experiential group. In both groups, the question that is most often left unanswered is question 10 (graduate 36%, 9/25 participants; experiential 26%, 6/23 participants). Question 12 is not answered by 32% of the graduate group (8/25 participants). Although questions 1 to 4 are answered by all participants, at least one of them is answered incorrectly by 40% of the graduate practitioners (10/25) and 43% of experiential practitioners (10/23).

**Figure 5.11. Section 2 – Questions left unanswered (DNA), as a percentage**

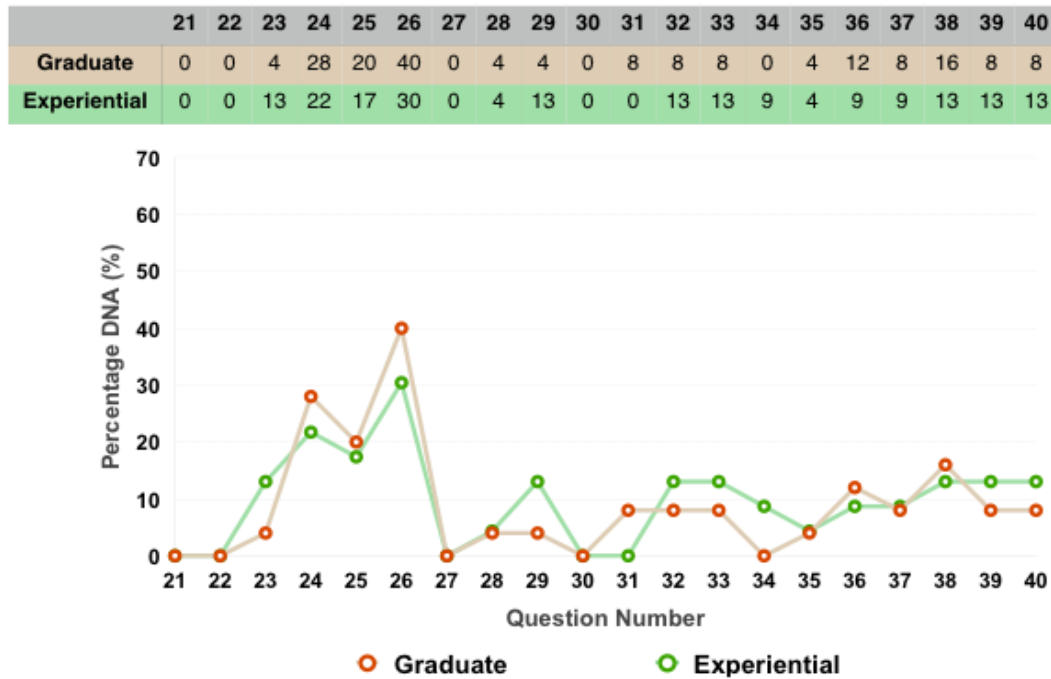


Figure 5.11. shows that out of the 20 questions in Section 2, 15 (75%) are left unanswered at least once in the graduate and experiential groups. Both groups follow a similar trend, and the most frequently unanswered questions in both groups are questions 24 to 26. The question most often left unanswered is question 26 (graduate 40%, 10/25 participants; experiential 30%, 7/23 participants). Question 24 is left unanswered by 28% (7/25 participants) of the graduate group.

**Figure 5.12. Section 3 – Questions left unanswered (DNA), as a percentage**

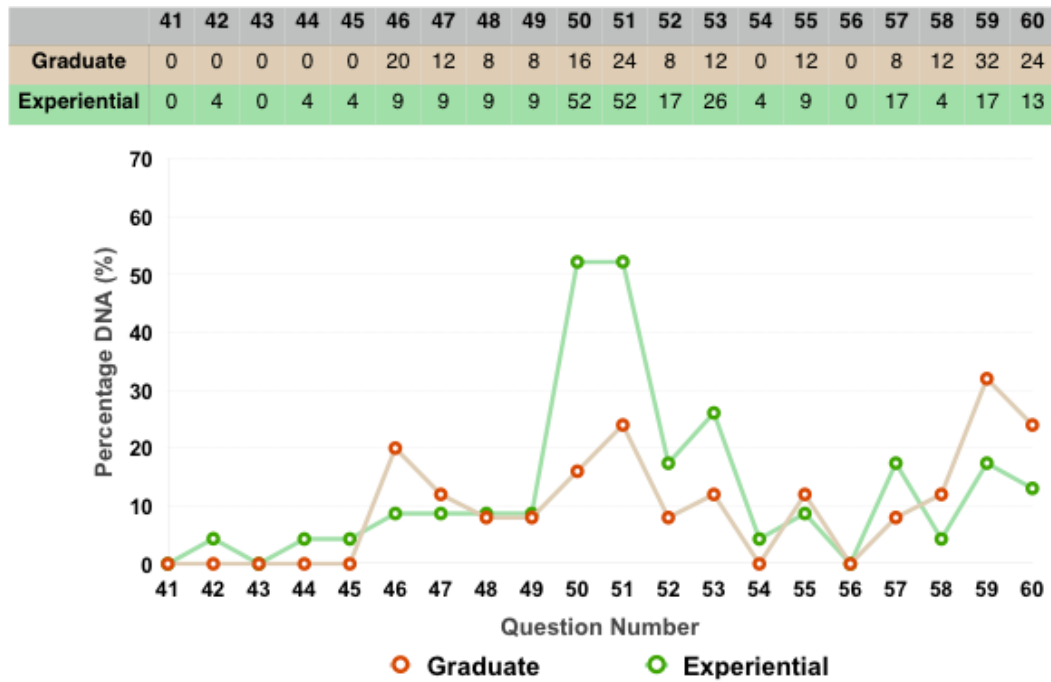


Figure 5.12. shows that out of the 20 questions in Section 3, 13 (65%) are left unanswered at least once in the graduate group and 17 (85%) are left unanswered at least once in the experiential group. In the graduate group the question most often left unanswered is question 59 (32%, 8/25 participants). In the experiential group the questions most often left unanswered are questions 50 and 51 (52%, 12/23 participants for both questions). In the graduate group, these two questions are left unanswered less often (16%, 4/25 participants, question 50; 24%, 6/25 participants, question 51). Question 53 is not answered by 26% (6/23) of participants in the experiential group.

**Figure 5.13. Section 4 – Questions left unanswered (DNA), as a percentage**

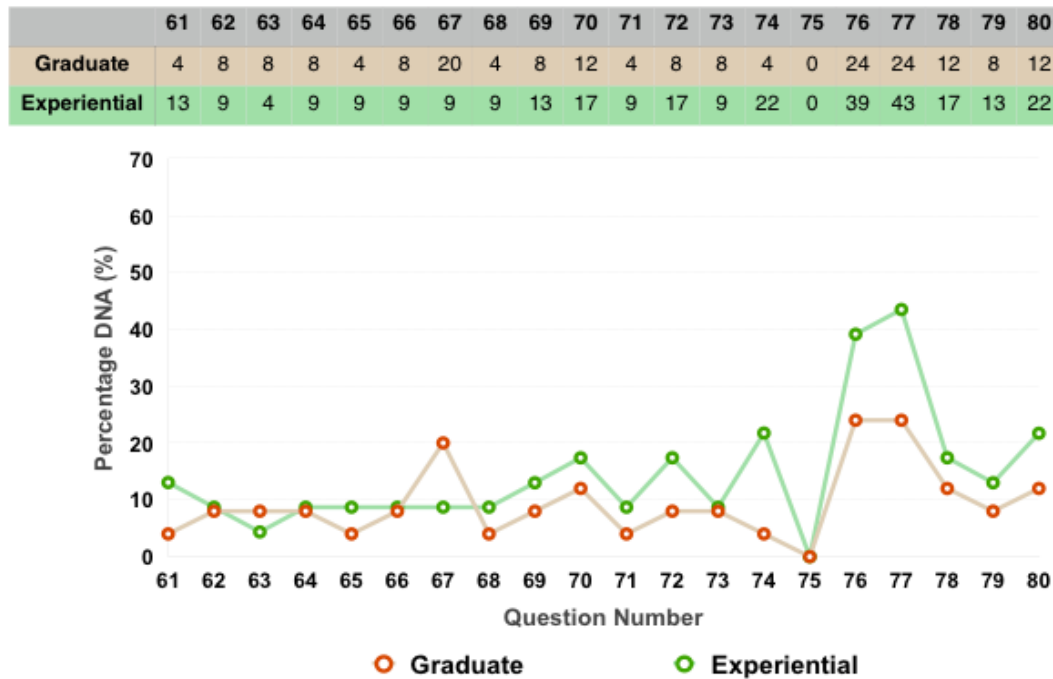


Figure 5.13. shows that out of the 20 questions in Section 4, 19 (95%) are left unanswered at least once in the graduate and experiential groups. In the graduate group the questions most often left unanswered are questions 76 and 77 (24%, 6/25 participants). In the experiential group the question most often left unanswered is question 77 (43%, 10/23 participants). Question 76 is not answered by 39% (9/25) of participants in the experiential group.



**Figure 5.14. Section 5 – Questions left unanswered (DNA), as a percentage**

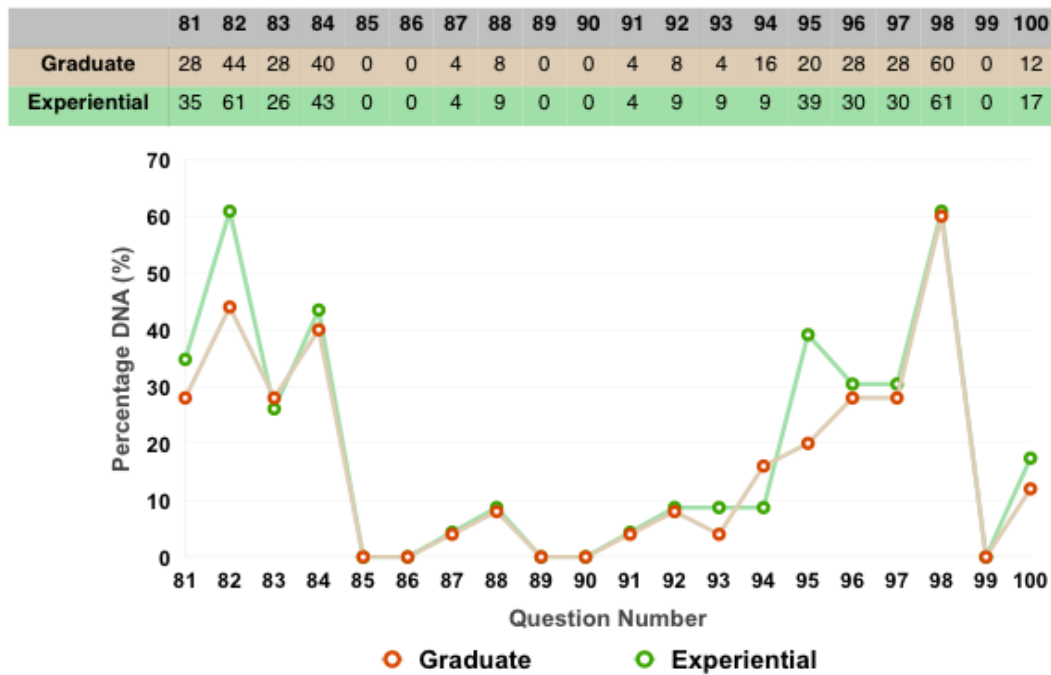


Figure 5.14. shows that out of the 20 questions in Section 5, 15 (75%) are left unanswered at least once in the graduate group and experiential groups. Both groups follow a similar trend in that questions 81 to 84 and 95 to 98 are frequently left unanswered. In the graduate group the question most often left unanswered is question 98 (60%, 15/25 participants). In the experiential group the questions most often left unanswered are questions 82 and 98 (61%, 14/23 participants).

Table 5.3. (p.155) summarises and compares the percentage of questions answered correctly, answered incorrectly and not answered (DNA) for each section. These percentages are calculated by dividing the total score for each category (correct, incorrect and DNA) for each section by the total possible score for every participant for each section (graduate=500 (25 x 20); experiential=460 (23 x 20)) and then multiplying this by 100 to achieve a percentage. The totals in each category are calculated using the same formula but with the total scores for the OSCE as a whole (graduate=2500, experiential=2300).

**Table 5.3. Percentage of questions answered correctly, incorrectly and DNA**

		<b>Section 1</b>	<b>Section 2</b>	<b>Section 3</b>	<b>Section 4</b>	<b>Section 5</b>	<b>Total</b>
<b>Graduate</b>	Correct	74.2	67.8	67.2	55.2	51.4	<b>63.2</b>
<b>Experiential</b>	(%)	69.3	53.7	56.5	43.5	44.3	<b>53.5</b>
<b>Graduate</b>	Incorrect	19.2	23.2	23.0	34.8	32.0	<b>26.4</b>
<b>Experiential</b>	(%)	24.3	35.9	30.4	41.9	36.3	<b>33.8</b>
<b>Graduate</b>	DNA	6.6	9.0	9.8	10.0	16.6	<b>10.4</b>
<b>Experiential</b>	(%)	6.4	10.4	13.1	14.6	19.4	<b>12.7</b>

Table 5.3. shows that the graduate group consistently provide more correct answers and fewer incorrect answers for all five sections and for the OSCE as a whole. With the exception of Section 1, fewer questions are left unanswered by the graduate group than by the experiential group.

**Table 5.4. Questions highlighted as being problematic**

<b>Section</b>	<b>Question</b>	<b>Topic</b>
<b>1</b>	1–4	Contraindications to MRI
	9 and 10	Reasons why it might not be safe to scan a particular patient
	12–16	Labelling anatomy and pathology in the spine, brain and knee
<b>2</b>	24–26	Nuclei that are used in MRI
<b>3</b>	50–51	Definition and examples of intrinsic contrast parameters
<b>4</b>	76–77	Phase encoding gradient
<b>5</b>	81–84	Consequences of changing the repetition time (TR)
	95–98	Consequences of changing the phase matrix

Table 5.4. illustrates the main questions that are problematic in that they are most commonly either answered incorrectly or not answered. They are discussed in detail in Section 6.2.1. In summary, although there are a few very high or very low scores, the descriptive data identify that in general, the graduate practitioners' performance is better in all five sections of the OSCE. The data also identify that

the performance of both groups is better in the first three sections of the OSCE than in Sections 4 and 5.

## **5.2.2. Inferential statistics**

The following inferential statistics are illustrated using figures and tables. The hypothesis that is tested in this section and the statistical tools that are used are explained and justified in Sections 4.3.1. and 4.3.2., respectively.

Firstly, the distribution of scores is shown to determine whether they are normally or abnormally distributed (see Section 4.3.2.). Levene's test is used to determine whether the variances can be treated as statistically similar, as this is important in subsequent tests. The total OSCE scores are then tested to determine if they are significantly different by using the two-tailed t-test for independent samples. A confidence or significance level of  $p < 0.05$  is used. The same test is performed on the total DNA scores, using the same confidence level. The effect that the undergraduate degree in MRI might have had on the total OSCE scores is then tested using the Cohen's effect size test (see Section 4.3.2.) Finally, the chi-square test is used to determine whether the observed numbers of correct, incorrect and unanswered questions are different or similar to those expected by chance.

### **5.2.2.1. Distribution of scores**

The distribution of marks and Q-Q plot for each group are shown in Figures 5.15. (p.157) and 5.16 (p.158). The estimated mean for each group using a confidence level of 95% is also illustrated. As most of the OSCE scores fall close to a straight line, the data follow the assumed distribution.

Figure 5.15. Graduate group score distribution summary

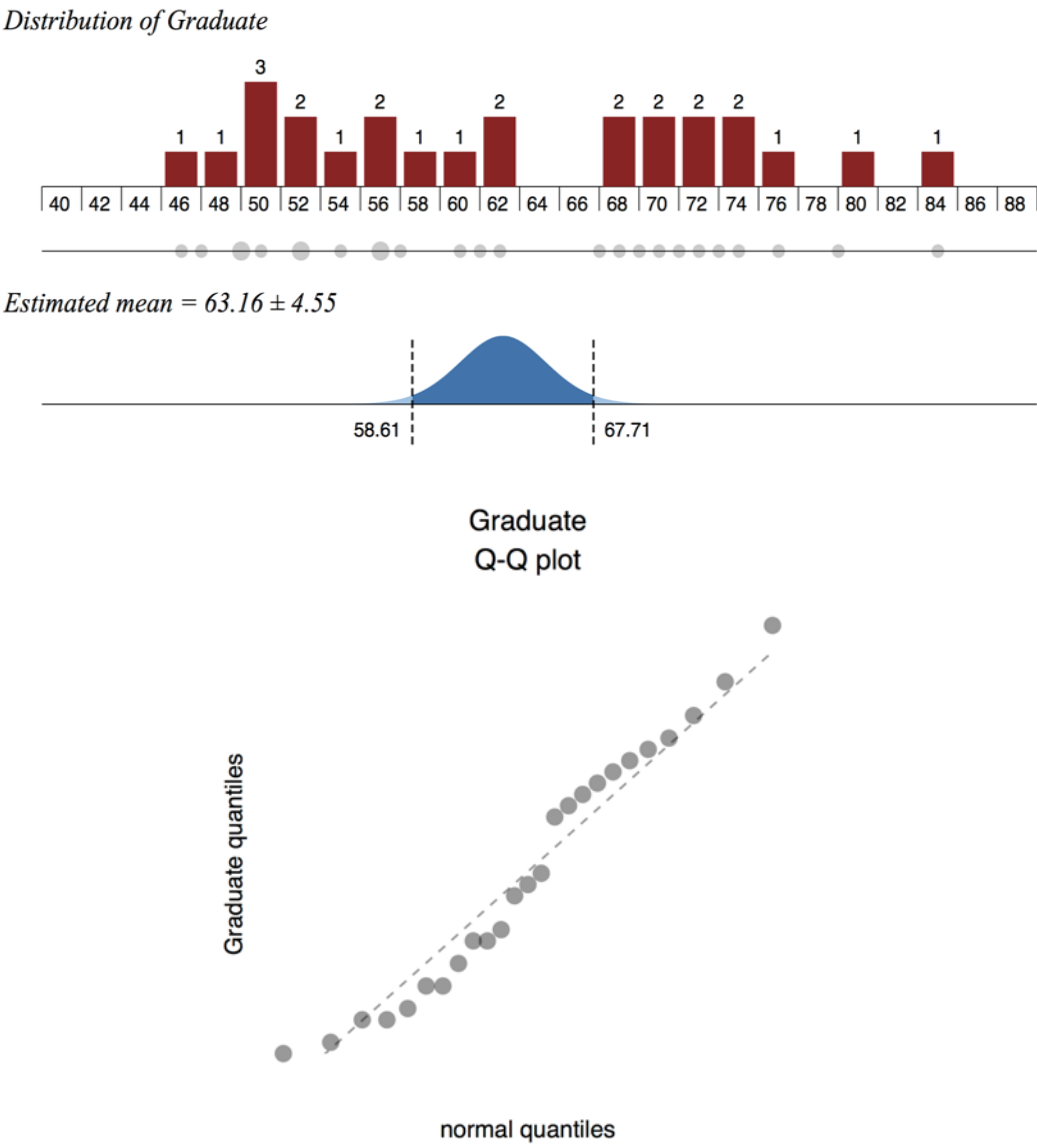
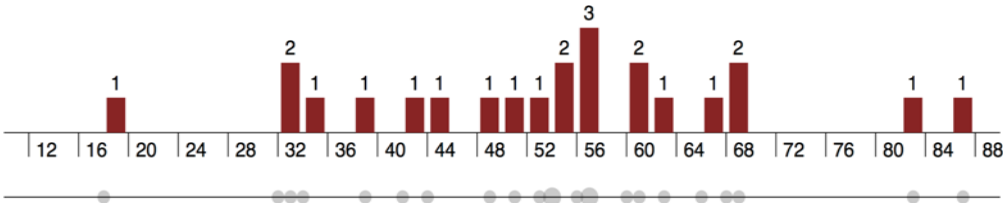
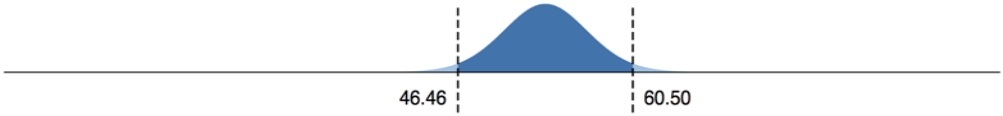


Figure 5.16. Experiential group score distribution summary

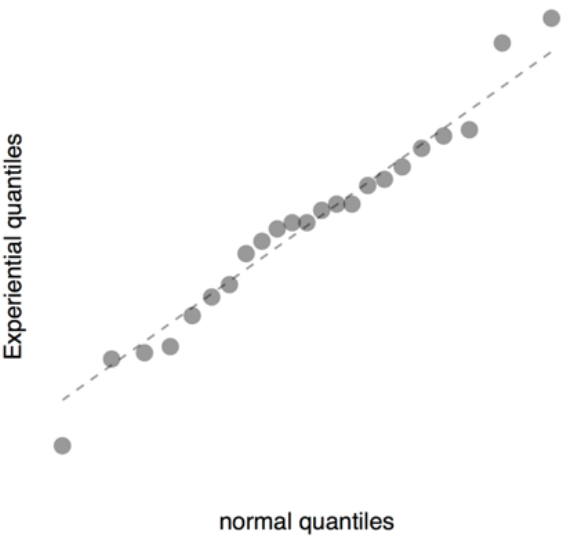
*Distribution of Experiential*



*Estimated mean = 53.48 ± 7.02*



Experiential  
Q-Q plot



### 5.2.2.2. Levene's test

Levene's test is used to test the null hypothesis that the group variances are equal at a confidence level of  $p < 0.05$  (see Section 4.3.2.). The results are shown in Table 5.5. The degrees of freedom (df,  $n-1$ ) are shown (graduate=24, experiential=22) along with the F score (1.18811) and p value (0.34400).

**Table 5.5. Levene's test**

Levene's test	df graduate=24, df experiential=22
F score	1.188
p value	0.344
significance ( $p < 0.05$ )	no

As the p value for Levene's test is higher than the confidence level ( $p < 0.05$ ), the obtained differences in sample variances are likely to have occurred based on random sampling from a population with equal variances. Thus, the null hypothesis of equal variances is **accepted** and it is concluded that there is **no** difference between the variances. Therefore, despite the fact that the descriptive statistical analysis reveals a difference, the variances are not significantly different and can be treated as equal for the purpose of inferential statistical testing.

### 5.2.2.3. Two-tailed t-test for two independent sample OSCE scores

The results of the two-tailed t-test are shown in Table 5.6 (p.160). A two-tailed test is conducted because, although the null hypothesis reflects the expectation that graduate practitioners do not have more residual knowledge of MRI than experiential practitioners, so graduate practitioners are not more likely to know the answer to a question, this is only a proposition and is not based on established theory. Therefore, a two-tailed test is used to reflect that either group might not be able to answer questions correctly. The t scores for the total OSCE scores and the scores for each section of the OSCE are compared. The critical value at a level of significance of  $p < 0.05$  and 46 degrees of freedom (graduate=24 + experiential=22) is 1.678.

**Table 5.6. Two-tailed t-test for two independent samples (OSCE scores)**

	SECTION					
t-test	1	2	3	4	5	Total
t score	1.289	3.385	2.048	2.031	1.354	<b>2.433</b>
p value	0.203	0.001	0.046	0.004	0.182	<b>0.018</b>
significance (p<0.05) (critical value 1.678)	no	yes	yes	yes	no	yes

The t-test confirms that the difference in OSCE total scores between the two groups is a highly statistically significant result ( $p=0.018$ ) at a confidence level of  $p<0.05$ . Sections 2, 3 and 4 are responsible for this result, as the differences in scores in all these sections are statistically significant ( $p<0.05$ ) and the difference in Section 2 is highly statistically significant ( $p=0.001$ ). The difference in the scores between the two groups is not statistically significant in Sections 1 and 5. As the graduate practitioners' total OSCE scores are statistically higher than the experiential practitioners' scores and this is significant at  $p<0.05$ , the null hypothesis is **rejected**. It is concluded that graduate practitioners **do** have more residual knowledge of MRI than experiential practitioners, and this is not due to chance alone.

#### **5.2.2.4. Cohen's effect size**

The results of the Cohen effect size test are shown in Table 5.7. (p.161). The rationale for this test is explained in Section 4.3.2. The effect size is large when comparing the total scores between each group (0.697, large=0.5 to 0.8). Sections 2, 3 and 4 also show a large effect size, with Section 2 being particularly impactful. Sections 1 and 5 show a medium effect size (medium=0.2 to 0.5).

**Table 5.7. Cohen's effect size (OSCE scores)**

	SECTION					
Cohen's effect size	1	2	3	4	5	Total
d	0.369	0.971	0.586	0.587	0.389	<b>0.697</b>
effect size	medium	large	large	large	medium	large

Thus, the null hypothesis is **rejected**. It is concluded that a specialised undergraduate MRI programme **does** have a large effect on the residual knowledge of an MRI practitioner.

#### 5.2.2.5. Two-tailed t-test for two independent samples (DNA)

The results of the t-test are shown in Table 5.8. The critical value at a level of significance of  $p < 0.05$  and 46 degrees of freedom (graduate=24 + experiential=22) is 1.6787. The t scores for the total number of unanswered questions and for the number of unanswered questions in each section of the OSCE are compared.

**Table 5.8. Two-tailed t-test for two independent samples (DNA)**

	SECTION					
t-test	1	2	3	4	5	Total
t score	0.476	0.364	0.719	0.881	0.564	<b>0.676</b>
p value	0.962	0.717	0.475	0.389	0.575	<b>0.501</b>
significance ( $p < 0.05$ ) (critical value 1.678)	no	no	no	no	no	<b>no</b>

The t-test confirms that the difference in questions that could not be answered by participants in each group is not a statistically significant result ( $p = 0.501$ ) at a confidence level of  $p < 0.05$ . There is also no statistical difference in any section of the OSCE test. Thus, the null hypothesis is **accepted**. It is concluded that there is **no** difference in the number of questions not answered by participants in either group



### 5.2.2.6. Chi-square test

The chi-square one-sample test (Tables 5.9. to 5.18., pp.162-164) is performed on each group to see if there is a good fit between the observed and expected data (data expected by chance) in terms of questions answered correctly, answered incorrectly or not answered (see Section 4.3.2.).

**Table 5.9. Chi-square test, graduate, Section 1**

Section 1	observed	expected	chi-square	p value	significance
Correct	371	316	9.57	0.49	no
Incorrect	96	132	9.81	0.49	no
DNA	33	52	6.94	0.49	no

**Table 5.10. Chi-square test, graduate, Section 2**

Section 2	observed	expected	chi-square	p value	significance
Correct	339	316	1.67	0.50	no
Incorrect	116	132	1.94	0.50	no
DNA	45	52	0.94	0.50	no

**Table 5.11. Chi-square test, graduate, Section 3**

Section 3	observed	expected	chi-square	p value	significance
Correct	336	316	1.27	0.50	no
Incorrect	115	132	2.19	0.50	no
DNA	49	52	0.17	0.50	no

**Table 5.12. Chi-square test, graduate, Section 4**

Section 4	observed	expected	chi-square	p value	significance
Correct	276	316	5.06	0.50	no
Incorrect	174	132	13.36	0.47	no
DNA	50	52	0.08	0.50	no

**Table 5.13. Chi-square test, graduate, Section 5**

Section 5	observed	expected	chi-square	p value	significance
Correct	257	316	11.02	0.49	no
Incorrect	160	132	5.94	0.49	no
DNA	83	52	13.48	0.38	no

**Table 5.14. Chi-square test, experiential, Section 1**

Section 1	observed	expected	chi-square	p value	significance
Correct	319	246	21.66	0.24	no
Incorrect	112	155	11.92	0.47	no
DNA	29	59	15.25	0.42	no

**Table 5.15. Chi-square test, experiential, Section 2**

Section 2	observed	expected	chi-square	p value	significance
Correct	247	246	0.004	0.50	no
Incorrect	165	155	0.65	0.50	no
DNA	48	59	2.05	0.50	no

**Table 5.16. Chi-square test, experiential, Section 3**

Section 3	observed	expected	chi-square	p value	significance
Correct	260	246	0.80	0.50	no
Incorrect	140	155	1.45	0.50	no
DNA	60	59	0.02	0.50	no

**Table 5.17. Chi-square test, experiential, Section 4**

Section 4	observed	expected	chi-square	p value	significance
Correct	200	246	8.60	0.49	no
Incorrect	193	155	9.32	0.49	no
DNA	67	59	1.08	0.50	no

**Table 5.18. Chi-square test, experiential, Section 5**

Section 5	observed	expected	chi-square	p value	significance
Correct	204	246	7.17	0.49	no
Incorrect	167	155	0.93	0.50	no
DNA	89	59	15.25	0.42	no

The chi-square one-sample test for scores in the graduate and experiential groups shows that there is a good fit between the observed and expected data for correct, incorrect and unanswered questions in all five sections for both groups. This means that the observed values are similar to what could be expected by chance rather than from any other influence. Thus, for both groups the null hypothesis is **accepted**.

It is worth noting that the chi-square values approach zero for all categories in Sections 2 and 3 in the graduate group. However, the chi-square value is higher for incorrect answers (13.36) in Section 4 and for correct and DNA (11.02 and 13.48) in Section 5. In the experiential group the chi-square value approaches zero in Sections 2 and 3 for all categories but the chi-square values are higher for all types of questions (correct, incorrect and DNA) in Section 1 (21.66, 11.92 and 15.25), for correct and incorrect in Section 4 (8.60 and 9.32) and for DNA (15.25) in Section 5. Although none of the chi-square values have statistically significant p values ( $p < 0.05$ ), the higher chi-square values point to instances where the actual and expected data are tending not to fit. This implies that these scores are tending towards being influenced by something other than chance.

**Table 5.19. Summary of inferential data**

		SECTION					
p<0.05 (df=46)		1	2	3	4	5	Total
t-test		no	Yes	Yes	Yes	no	Yes
Cohen's effect size		medium	Large	Large	Large	medium	Large
Graduate	Chi-square	no	no	no	no	no	—
Experiential		no	no	no	no	no	—

Table 5.19. (p.164) shows that Sections 2, 3 and 4 have similar inferential data. The differences between the scores of each group are statistically significant with a corresponding large Cohen's effect size. The chi-square test shows that there is a good fit between actual and expected answers in both groups in all five sections, although there are higher chi-square values in some instances.

### 5.2.3. Summary

The quantitative findings show that in this study graduate practitioners perform better than experiential practitioners in the OSCE. The total mean score of the graduate group is higher than that of the experiential group, and the total mean scores are higher for the graduate group in all five sections. The scores attained by participants in both groups are lower in Sections 4 and 5 than in Sections 1, 2 and 3. However, in all five sections the graduate group consistently achieve a higher percentage of correct answers and a lower percentage of incorrect answers than the experiential group. In Sections 4 and 5, a higher percentage of questions are left unanswered by both groups (Table 5.3., p.155).

Although the highest scores are quite consistent and comparable in all sections in both groups, there is a variation in the lowest scores. Therefore, there is a difference in the range, standard deviation and variance between the two groups. This is reflected in the differences in the median and mean scores. However, the scores of each group are evenly distributed and the total scores have statistically equal variances.

The total OSCE score in the graduate group is statistically significantly higher than the total score for the experiential group, with a significance of  $p < 0.05$ . There is also a large Cohen's effect size, indicating that the effect being tested (the specialised undergraduate degree in MRI) does have an impact on the OSCE scores. Sections 2, 3 and 4 yield significant differences in the number of questions answered correctly between the groups, with the difference for Section 2 being highly significant. These sections also have a large Cohen's effect size.

Overall, the quantitative data suggests that the graduate practitioners in this study have a higher level of residual knowledge of MRI than the experiential practitioner, especially in relation to the general principles of MRI, image contrast and pulse

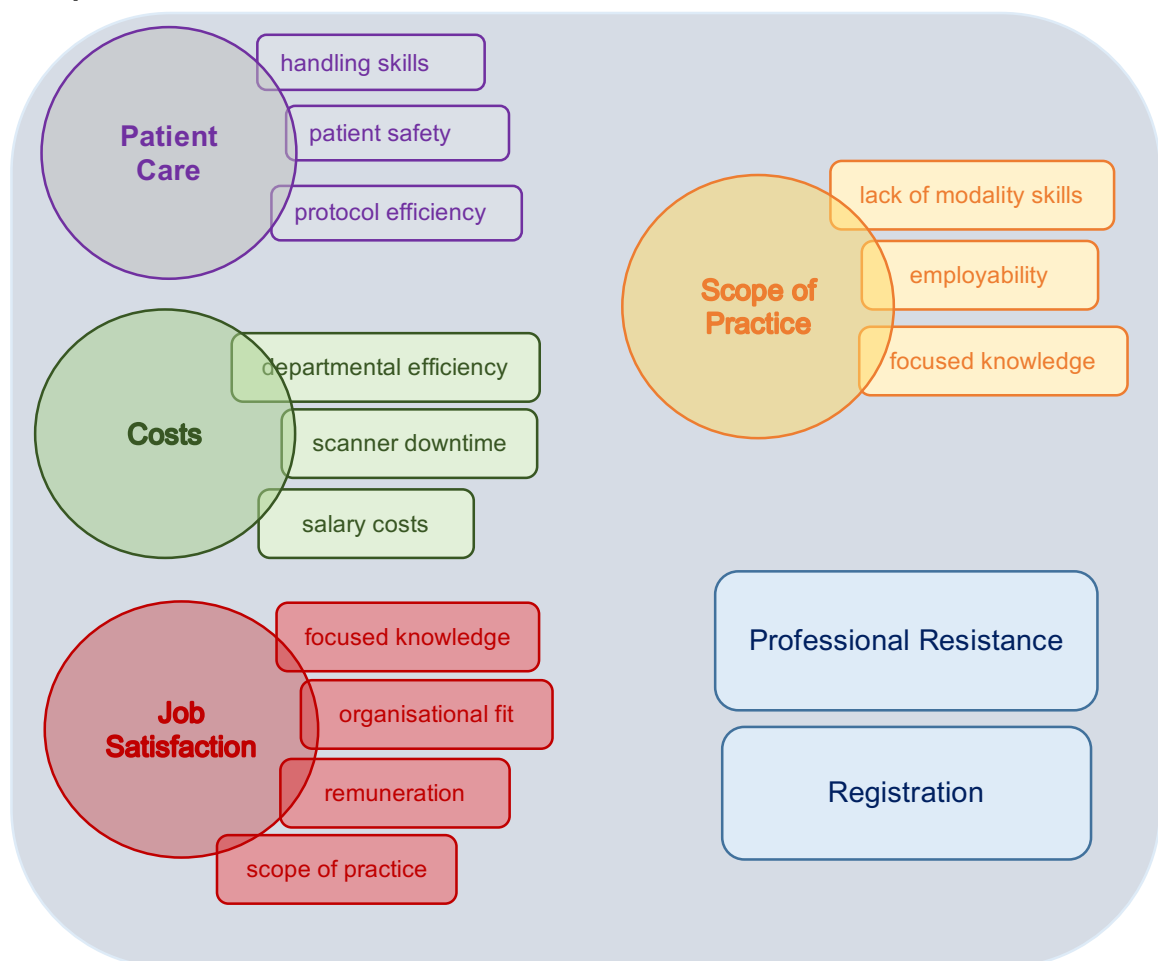
sequences, and image acquisition. Although it is possible that the results could have been achieved by chance alone, the high level of significance suggests that the way in which MRI is learned has a specific impact on residual knowledge.

## 5.3. QUALITATIVE FINDINGS

### 5.3.1. Themes and coding results

The general themes explored via semi-structured interviews with eight stakeholders are illustrated in Figure 5.17. The main themes (shown in circles in Figure 5.17.) emerged from a review of the literature surrounding specialisation and direct entry into professions allied to health. The sub-themes (shown in rectangles in Figure 5.17.) emerged from the analysis of the interview transcripts. The themes related to professional resistance and registration emerged from the literature and were further explored in some of the interviews.

**Figure 5.17. Qualitative themes: professional benefits of and barriers to specialisation**



The number of parent and child nodes generated using NVivo for Mac (version 10.2.2) are detailed in Table 5.20. The parent nodes are themes identified by the literature as important to this topic (shaded orange in Table 5.20.). The child nodes were generated by splitting the parent nodes into different categories and emerged from the interview transcripts (shaded white in Table 5.20.). Issues surrounding scope of practice, especially lack of modality skills and employability, were coded most frequently, which indicates that these are important topics.

**Table 5.20. Coded parent and child nodes**

Parent node	Child node	No. of sources	No. of references
Patient care	Handling skills	6	18
	Patient safety	3	45
	Protocol efficiency	3	16
Costs	Departmental efficiency	4	12
	Scanner downtime	2	8
	Salary costs	1	2
Scope of practice	Lack of modality skills	4	74
	Employability	6	54
	Focused knowledge	2	18
Job satisfaction	Focused knowledge	3	36
	Organisational fit	1	19
	Remuneration	3	2
	Scope of practice	2	63
Professional resistance	Professional resistance	4	15
Registration	Registration	6	29

The following sections provide a discourse on the qualitative data. Individual responses are woven into a description of the findings. Words in italics and brackets indicate the context of the comment.

### 5.3.2. Patient care

Most of the interview respondents generally agree that specialisation in a discrete area of practice is better for patients in three key areas: patient-handling skills, patient safety and protocol efficiency (which affects patients' experience of the scan). The impact on patients of being scanned by graduate practitioners or by experiential practitioners emerges from a discussion of the benefits and drawbacks of employing graduate practitioners and interviewees' views on the meaning of specialist practice.

#### 5.3.2.1. Handling skills

**AC:** ...but we had a couple (*of undergraduate non-radiographic students*), they start squirming when you're talking about patient care...they are really timid talking with the patients...

**EXP1:** ...so, when they (*undergraduate non-radiographic students*) come in, depending on who they are, they are at a disadvantage clearly, because they don't know their way around a hospital, they don't have nearly the experience in handling difficult patients that a radiographer would have...

**CMUSA:** We had a gentleman ask for a urinal. OK, MR-only trained tech (*undergraduate non-radiographic student*), couldn't accomplish the task an RT (*radiologic technologist or radiographer*) knows how to do that and if somebody needs to vomit, an RT can handle that. A lot of times, the MR-only student has not had the clinical experience to do that OK and again, that depends on the individual. So, if they served in a capacity somewhere as an aide, for example, OK then they have that.

**CMUK:** I think one of them (*assistant practitioner*) was in graphic design and another one was something completely unrelated to clinical practice, but they had the qualifications and they showed the aptitude for patient care...

**EXP2:** ...in fact, if these kids (*graduate practitioners*) are providing a better experience for the patient because they are younger, energetic and they care, whereas all regular techs (*experiential practitioners*) care about is the pay cheque at the end of the day...

Six respondents provide perspectives about the importance of patient-handling skills, but some of these are conflicting. All six respondents emphasise the need for MRI practitioners to have these skills, but there is disagreement over whether graduate practitioners are disadvantaged because they do not have a general radiographic background. The academic respondent (AC) acknowledges that some students with a non-radiographic background lack patient-handling skills when compared with students who have previously trained in radiography. This point is reinforced by the USA clinical manager (CMUSA) and the first experiential practitioner (EXP1). CMUSA provides some explicit examples of students with a non-radiographic background dealing with a patient situation inappropriately, but she also acknowledges that a person's patient-handling skills are dependent upon



the individual. These statements are, however, contradicted by the UK clinical manager (CMUK) and the second experiential practitioner (EXP2). CMUK argues that radiographers also often lack patient-handling skills and that assistant practitioners do have these skills despite having no previous clinical experience. By contrast, EXP2, who works in an entirely different department, states that in his experience, graduate practitioners have a different work ethic from experiential practitioners and this often results in better patient care. He makes a link between their youth and energy and their ability to improve the patient experience, and contrasts this with experiential practitioners, whose motivations are financially driven.

Further questioning of CMUSA reveals a clarifying insight.

**INTERVIEWER:** ...you kind of mentioned about patients and patient care but is it more to do with the fact that the students haven't got the experience yet... if they're both qualified people with, say, two years of experience, would you expect any difference between the two?

**CMUSA:** ...No, I would not.

CMUSA initially compares undergraduates with qualified radiographers rather than student radiographers. After further questioning, she states that there is no difference between the patient-handling skills of students in the two groups. EXP1 is also a little vague in this regard. Using the term 'they' to refer to non-radiographic students, he seems to make comparisons between these students and radiographers. EXP2 and the second graduate practitioner (GRAD2) draw on examples from their own experience to emphasise how patient-handling skills are more important than what is learned in the classroom.

**EXP2:** ...like my mother has cancer...those experiences make me a better technologist because I know...how techs should be treating a patient because I see how techs treat my mother and so forth. Those things I think are a lot more important than what you can teach in a classroom, because those things I think made a greater impact on the patient experience than anything.

**GRAD2:** I'm a people person first and foremost; I get that through this job all the time...that's what it (*my job*) is, is a human services job. I'm interacting with people, I'm talking them off of ledges, so to speak, going into this little tiny tube...

This notion is illustrated by GRAD2, who uses an example of scanning a claustrophobic patient. He feels that he has the patient-handling skills required for his role despite having a non-radiographic background.

### 5.3.2.2. Patient safety

**EXP1:** I think the patients get a better quality of care because of that (*specialisation*)... so, the people that do their test, that's all they do. It's like going to a general surgeon or a neurosurgeon when you have a brain tumour. Do you want to go to the general guy, maybe he can pull it off and maybe not, he did it once a long time ago.

**AC:** ...there are technologists out there that don't know, they don't know what they're doing. They are button-pushers and that's a scary thought...and it's just scary and then you have all the MRI safety issues, which is huge.

**CMUK:** This way (*by having an undergraduate curriculum*), they (*graduate practitioners*) would know that you can't go in there with a pacemaker or something like that.

Three of the eight respondents refer to patient safety in their answers. In a general discussion about specialist practice, EXP1 emphasises the importance of specialisation in a discrete area of practice, although he uses the term 'patient care' rather than 'patient safety'. He uses an analogy of a neurosurgeon removing a brain tumour to illustrate that specialisation is better for patients. AC raises the importance of MRI safety and expresses concern over what she sees as a lack of this knowledge amongst experiential practitioners. She uses the word 'scary', reflecting the significant potential dangers associated with MRI. AC and CMUK both mention this, and CMUK refers specifically to pacemakers, which are contraindicated in MRI because the strong magnetic fields can interrupt their function.

### 5.3.2.3. Protocol efficiency

**CMUK:** ...if you are very expert in MR and you've got a claustrophobic patient, you are very good at adapting your technique or making faster imaging, you are more likely to get better imaging, compliance from your patient and be able to scan them in 20 minutes than if you're not in there quite so often because it could take you 40 minutes and you have an undiagnostic scan at the end of it.

**AC:** They (*experiential practitioners*) trained on the mobile, just do this, this is what you cover, this is what you hit, have no idea what they are changing and that's how things happen that you get really bad pictures... they (*graduate practitioners*) look more than just doing this and just doing the scan, get the patient on the table, get the scan and go... I just think they think of more things and what can I do, I'm looking for things to add to...

**CMUK:** ...and usually the AP (*assistant practitioner*), because they want to make sure that they've done a good job, will do that extra sequence to cover that a bit more, put a few more slices on it or whatever it might be...so, that was sold to them right at the beginning, this is patient care, you're taking pictures of patients and diagnosis depends on it.

**EXP1:** Plus, she (*a graduate practitioner*) got to experience a much larger facility that has nine MRI scanners and all they do is scan and so she's definitely clearly a benefit because she brings new ideas, she brings a different way of doing things and she does have some formal educational background and MRI so she understands a little more how to improve quality.

Three respondents make references to the impact of protocol efficiency on patients. CMUK uses an example of claustrophobic patients and describes how protocol efficiency influences the amount of time MRI practitioners spend on performing scans. AC compares the competencies of graduate and experiential practitioners and highlights that graduate practitioners are often more motivated to improve the scan. The scan-efficiency skills of practitioners who do not have a radiographic background are reinforced by CMUK and EXP1. Both refer to assistant or graduate practitioners who they work with and their scanning competencies. (As mentioned previously, assistant practitioners are not radiographers but possess a foundation qualification in MRI. They are the closest approximation to graduate practitioners in the UK.)

### 5.3.3. Costs

The employment costs of graduate and experiential practitioners were explored. Three different themes emerge through questioning on the potential benefits and drawbacks of employing graduate practitioners: departmental efficiency, scanner downtime and salary costs. Most of the responses come from AC (who has a history of practice as a departmental manager and an academic) and both clinical managers.

#### 5.3.3.1. Departmental efficiency

**AC:** ...techs who learn on the job (*experiential practitioners*), they don't have the background, they don't know why you know, how things work, they can't change parameters knowledgeably and that's why you end up with crummy pictures right and things that take too long.

**AC:** ...you have a knowledgeable technologist, you're going to save that institution money because you can get what you need first time, you're not calling patients back...you see the abnormalities...you know what you need to get through that, to give them extra pictures of what's going to be beneficial...call back for the patients is decreased.

**CMUK:** I would say radiographers (*experiential practitioners*) make more mistakes sometimes than your AP...usually the AP (*non-radiographic MRI practitioner in the UK*), because they want to make sure that they've done a good job, will do that extra sequence to cover that a bit more, put a few more slices on it or whatever it might be. I have to say I don't think I ever recalled a patient from an AP but I have from a radiographer.

**CMUK:** She (*the AP*) can run her own lists and all we do is check with her work at the end of it, which helps support the MR department, particularly at a time when we couldn't recruit radiographers...we probably kept these APs for probably 2 or 3 years longer than possibly than we would have done. I think they would have moved on probably.

**CMUSA:** ...if I put an RT (*experiential practitioner*) into the department, OK, there would be a much larger cost...the time to utilise those team members, when can they work alone, when they can take call, when they can work weekends, you know when can they cover

vacation on their own and everything...I say three to six months (*for a graduate practitioner*) or... a year for an RT (*experiential practitioner*).

**COR:** So, you could probably train that person (*graduate practitioner*) in that modality to a higher level because that is their core focus and they will probably be able to go into the service and be more effective from day one.

Four respondents comment on the importance of employing MRI practitioners who have enough knowledge to optimise protocols and, therefore, patient throughput. AC explains that experiential practitioners (whom she refers to as 'techs who learn on the job'), sometimes lack the knowledge and skills to scan patients efficiently. AC's perspective emphasises the cost-benefits of graduate practitioners' reduced patient-recall rates. CMUK also states that patients are recalled less often when they have been scanned by an assistant practitioner than when they have been scanned by an experiential practitioner. She also points out that assistant practitioners stay in post longer because they have been given special training in MRI.

CMUSA refers to efficiency in the context of the effect of training on the department. According to AC, graduate practitioners can be used to their full potential sooner than experiential practitioners, who require lengthier training. The notion of effectiveness is reinforced by the representative of the professional body (COR), who accepts that someone trained in a specific area of practice is more likely to become an effective practitioner quicker than someone who has not received this training.

### 5.3.3.2. Scanner downtime

**AC:** ... they (*experiential practitioners*) have no idea what they're changing and that's how things happen that you get really bad pictures, they think something is wrong with the equipment.

**AC:** ...if there's something wrong you know, if something happens where the magnet or the equipment... somebody who has been trained is more knowledgeable can get through that, save your downtime, save the call in from the service engineer.

**GRAD1:** I think we have a little bit more knowledge of the background of it. So, if issues arise like with artefacts or equipment function, we can diagnosis a little bit easier than someone who has no idea of what actually goes on in a machine, whereas they (*experiential practitioners*) would just immediately call service or something when it could be just a simple fix.

Two respondents make a reference to scanner downtime. AC comments on how experiential practitioners sometimes blame poor image quality on a system fault because they lack an understanding of how protocol parameters affect image

quality. In the experience of AC, trained practitioners have a deeper understanding of these issues and are less likely to call out the service engineer unnecessarily. In addition, the first graduate practitioner (GRAD1) believes that her specific training in MRI minimises engineer callouts and scanner downtime.

### 5.3.3.3. Salary costs

**CMUSA:** ...a new MR graduate from a programme will make more (*money*) than a new RT graduate (*experiential practitioner*), which I find very interesting based on this conversation... because they (*graduate practitioners*) are already registered.

One respondent makes a reference to graduate practitioners who gain the ARRT certification in MRI. CMUSA believes that this is a factor that determines salary and, because most graduate practitioners are registered with the ARRT, they are likely to earn a higher salary than unregistered experiential practitioners (referred to here as RTs).

### 5.3.4. Scope of practice

#### 5.3.4.1. Lack of modality skills

**GRAD1:** I can see it being a problem if, say, if you don't do very many MRIs in the hospital and they want you to fill in on X-ray or, because I know in another hospital... they only do a couple of MRIs a day, so their MRI tech (*experiential practitioner*) will also take X-rays or do CTs, whereas I couldn't go to that hospital because I don't know how to do that.

**GRAD1:** ...it hasn't been too much of a problem just because of the way the hospital is staffed.

**INTERVIEWER:** Are there problems with that (*limited scope of practice for graduate practitioners*) in terms of the roster here?

**CMUSA:** Not at this point and not in this size of an institution.

**AC:** In a smaller hospital, I can see where it would be nice to have somebody that does X-rays and MR. We had...several X-ray technologists that were trained in MRI (*experiential practitioners*) and you would think, you know if you have to clear somebody for foreign body...you have to do Waters' view (*a type of X-ray that looks for metal fragments in the eye*) that an X-ray technologist who can just go back and take that picture...but they (*graduate practitioners*)...they don't. They don't because they are MR.

**CMUK:** ... MRI radiographers (*experiential practitioners*) actually go up and do X-ray, so they've had to knock the dust off their brain cells after a number of years specialising in MR... I've lost or deskilled in that area because I've gone in a different career direction...

Four of the respondents comment on the inability of graduate practitioners to undertake examinations in other imaging modalities. GRAD1 admits that not being able to perform other types of examinations could be a problem if she were to work in a department where there were no radiographers. However, she clarifies this by

saying that in practice this has not been a problem because of the type of department she works in. This is reinforced by CMUSA and AC, who report that although radiographers are qualified to carry out X-rays, many of them do not do this because they see themselves as only MRI practitioners. This is supported by CMUK from the perspective of deskilling. She implies that MRI practitioners (who are experiential learners in her department) might find it difficult to perform X-rays because they specialise in MRI. AC and CMUK both refer to whether an undergraduate MRI curriculum could include learning about the Waters' view (an X-ray projection needed if MRI patients are suspected of having metal in their eye), so that graduate practitioners can carry out these examinations if necessary.

**AC:** ....well, see there's the problem when they are a button pusher with the Waters' view and to be able to take X-rays you have to have radiation protection and you know, all the classes on radioactive material...I don't think it would fit into the curriculum because there is much more to it than learning to be able to take that X-ray.

**CMUK:** ...put it this way, if there was a course like the intra-orbital foreign body course, an MRI radiographer could probably go on that course and receive the appropriate training to do referral under IR(ME)R (*Ionising Radiation Medical Exposure Regulations*), most likely actually given those tools during that training. So, I think there's even a test at the end of it. So, I think you've had your anatomy lesson, you've had your IR(ME)R lesson, and you've had this is what orbits look like on X-rays, this is what orbital foreign bodies look like, here's a test.

These two respondents disagree on this idea. AC feels that it would not be appropriate to include the Waters' view in the curriculum because students would have to learn topics that surround the subject, such as radiation protection. She warns against creating a practitioner who only has enough knowledge to 'push the button' rather than an in-depth understanding of the technique. CMUK, however, sees no problem with providing this additional learning to graduate practitioners via an extra course in this specific area of practice. She emphasises the need to include specific topics, such as radiation protection and anatomy. She makes a reference to the Ionising Radiation Medical Exposure Regulations (IR(ME)R), which all radiographers and other practitioners using ionising radiation must adhere to in the UK. Finally, CMUSA links skills in different modalities with specialist practice. She states that graduate practitioners are not specialists because they cannot be moved around a multi-modality department.

**INTERVIEWER:** Would you consider them (*graduate practitioners*) less of a specialist than somebody who's a tech and has got all these additional skills (*experiential practitioner*)?

**CMUSA:** I would consider them less of a specialist only because I can't move them from modality to modality.

### 5.3.4.2. Employability

**INTERVIEWER:** Are there any drawbacks to employing somebody who wasn't a radiographer and could only do MRI?

**CMUK:** In my clinical situation, probably not...I guess, in your NHS or your department that has a number of modalities that people roster or rotate through, that wouldn't be able to particularly happen with that type of staff member, they could only specifically be in that department.

**CMUK:** ...our X-ray department is so small, we have enough radiographers that could actually cover that. We'd run into trouble I think if we took on completely MR-trained only people with no underpinning knowledge of IR(ME)R or any radiography. That would potentially become an issue but that would be over a long time with a lot of staff just being very MR-specific trained...a lot of departments for MR are very removed from the rest of the imaging department anyway and they have their own specific staff.

**INTERVIEWER:** Are there problems with that (*employability*) in terms of the roster here?

**CMUSA:** Not at this point and not in this size of an institution.

**CMUSA:** We're very much supportive of the (*undergraduate MRI*) programme because its RTs, MR, ultrasound and other students come through our department so we have a look at them and we can assess who will be the best fit...and skill level of personality and all those kinds of things...We are moving towards hiring those that are MR-trained only.

**CMUSA:** ...based on our conversation, OK, if I have an MR candidate who is a non-RT (*graduate practitioner*) and an MR candidate who is an RT (*experiential practitioner*) and if they are equal in every other aspect, I will hire the RT...but if my practice is MR only, if I own a stand-alone MR clinic and I don't have that need, then maybe the consideration would be a little bit different.

Six of the respondents refer to employability when asked about their opinions on the drawbacks of graduate practitioners who practise MRI only. CMUK emphasises that it very much depends on the size and make-up of the department.

Furthermore, she points out that in her experience, many MRI departments are geographically separate from the rest of the hospital and, therefore, they are isolated. Thus, in practice, MR practitioners are not commonly called upon to cover other modalities.

This view is supported to some degree by CMUSA, although she makes a few contradictory statements. Initially, she states that she employs more graduate practitioners and that if they were on clinical placement in her department as students she knows that they fit the organisation. However, later in the interview, she comments that all other things being equal she would choose to employ an experiential (called an RT) rather than a graduate practitioner. She acknowledges, however, that this may be different in other types of facilities.



**CMUSA:** So, I think it is advantageous to me as a manager to be able to move somebody around if I need to...and I think more and more we're going to find that to be the case that we need to be able to employ associates who can do several things...cost is going to be a big thing...and if our volumes decline then our staffing is going to decline also and... team members will be more valuable to me and actually to themselves if they can do multiple things.

**COR:** I also think it then limits the workforce to a very specific area. Also, if you train in one area, actually then how easy is it to go back and then develop and be more flexible? I mean, if MR sort of went, you know, I'm sure it's not but, you know, in five or 10 years there might be some other new, I don't know x, y, z, and you've got to retrain that workforce again.

**CMUK:** There's no future that doesn't include MR, so there will always be the opportunity to expand yourself or digress within your MR field. So, I don't think your opportunities would be limited, unless you are looking for roles actually within a department where they roster people through different imaging modalities.

**CMUK:** I can't see anything ever stopping or contracting in the MR world, I think potentially going forward the world is going to be pretty much people's oyster...there will always be a place and a role for that MR radiographer. I can't see that they would ever not get any work or have a career direction...

**CMUK:** I'd take somebody (*a graduate practitioner*) on. I mean, we trained APs because we couldn't recruit, couldn't find any radiographers.

CMUSA then goes on to make statements about the future, when, as she sees it, it will be very important for imaging practitioners to have skills in multiple modalities. This view is supported by COR, who sees a limited scope of practice as detrimental because it does not future-proof an individual from new developments in imaging. CMUK disputes these views. She sees no future without MRI and believes that the opportunities for properly trained MRI practitioners are limitless. CMUK raises some further points about what drives recruitment and influences employment decisions. She highlights that many radiographers in the UK want to practise MRI but that opportunities are commonly limited. She also indicates that there is a lack of qualified MRI practitioners and that this influenced her decision to hire assistant practitioners trained in MRI.

The potential limits to employability of graduate practitioners are reinforced by EXP1. He makes the same points as CMUK and CMUSA in that employability depends on the type of department. In his opinion, experiential practitioners are considered more employable but in practice they may never be called upon to work outside MRI.



**EXP1:** The fact that you are a generalist doesn't really make any difference here, because the only thing that are you actually asked to do is MRI...here in this specific department it is not an issue because when you do MRI you do MRI.

**INTERVIEWER:** Did you find it easy to get a job?

**GRAD1:** Yeah...I think I had the job before even I took the registry (*ARRT certification in MRI*).

**GRAD2:** Well, the standard of education that they know coming from just down the street is something that I'm sure helped get me the job. The fact I had a clinical experience here and must have done something right to show them that I could do the job, helped.

**INTERVIEWER:** Are you concerned about sort of your employability in the future at all?

**GRAD1:** I don't think so.

GRAD1 and GRAD2 state that graduate practitioners easily obtain employment after qualification. GRAD1 and GRAD2 state that they got jobs immediately after graduating. Although both understand that their scope of practice is limited, this does not seem to concern them. GRAD2 reinforces a point made saying that being a student in a department helped him to get a job there after qualification because the employer knew his abilities. GRAD2 is more concerned about the attitude of a radiologist than his own employability. He also reveals that, contrary to being worried about his focus on MRI, this is exactly why he wanted to practise MRI in the first place.

**GRAD2:** ... there is a large, very large hospital on the other side of town and they have a radiologist who says he doesn't want any MR tech that doesn't have X-ray training (*graduate practitioner*). So, I will never work there...

**INTERVIEWER:** And that doesn't bother you at all...?

**GRAD2:** It bothers me that he's so narrow-minded, yeah. absolutely.

**INTERVIEWER:** Does it concern you that you can only do MRI?

**GRAD2:** ...that's the only thing I got in it for.

#### 5.3.4.3. Focused knowledge

**EXP2:** ...When I first started, I thought you needed a firm background in radiology whatever the background was, but I've come to learn that no, you don't have to, it's helpful but then only if you're willing to use it, because I see lots of X-ray techs or RTs that are doing MR (*experiential practitioners*) and then they don't use their knowledge...

**COR:** ...some of the drawbacks are that they might not understand the wider imaging modalities that exist out there to enable them to make informed decisions about actually, would it have been better if this person had a CT or would it have been better for this person had a plain X-ray, for example, or an ultrasound scan and so, to me, there's something around those core areas which I think you need that knowledge across the spectrum.

**COR:** ...we need that crossover between the different modalities because we believe that someone needs that core knowledge at the bottom...

Two respondents compare knowledge and competency between specialist and generalist practitioners and reveal some tensions and conflicts. EXP2 feels that specialised practice leads to a higher level of knowledge and that although general diagnostic radiographers (whom he calls X-ray techs or RTs) have knowledge of a wide range of diagnostic imaging, they lose this knowledge once they specialise in MRI. COR's views reflect the UK professional body's resistance to removing MRI from the core skills of a radiographer. MRI practitioners need to understand how MRI fits into the diagnostic pathway, but COR does not consider that this could be taught within a specialised undergraduate programme.

### 5.3.5. Job satisfaction

The theme of job satisfaction emerges from discussion about the benefits of employing graduate practitioners. Many issues are touched upon by most of the respondents. These revolve around how graduate practitioners fit into the culture of a department, how well they are remunerated, and how having a good understanding of MRI enables graduate practitioners to make an important contribution. Some comments focus on the narrow scope of practice and whether that narrowness leads to boredom.

#### 5.3.5.1. Focused knowledge

**GRAD1:** ...every day I get to work and just doing MRI, which is what I enjoy, instead of maybe being tossed around and doing things that I don't enjoy.

**GRAD2:** I mean, that's what it is, is a human services job. I'm interacting with people... I have math and science are some of my fortes...I've learned all the protocols, I've done everything satisfactorily enough that they (*his employers*) are confident in my skills.

**GRAD2:** I think (of) myself as a highly trained professional that's responsible for people and their wellbeing while they are in certain environments and getting them the highest quality imaging in order to help them determine what's wrong.

**CMUK:** I can say, we retained our radiographic assistants (APs) who would probably have left and gone on to do other things by being able to offer them an assistant practitioners course in MR. So, we probably kept these APs for probably two or three years longer than possibly than we would have done. I think they would have moved on, probably.

Three respondents refer to the rewards of possessing good knowledge and understanding of MRI. This allows practitioners to function at a high level of practice, which leads to enjoyment in their role. GRAD1 specifically enjoys the focused role in MRI. GRAD2 feels that the knowledge and skills required to be a professional MRI practitioner play exactly to his strengths. He derives a high

degree of satisfaction from professional status and making a difference to a patient's diagnosis. CMUK recognises the importance of education and training in MRI in retaining assistant practitioners and attracting experiential practitioners who have found it difficult to gain a foothold in MRI in other departments that do not offer these opportunities.

#### 5.3.5.2. Organisational fit

**AC:** (A) lot of our students are hired by the clinical sites because then they know, I mean since they've spent time there, they... know what they are doing (*and if*) they fit with the department or not, which is really nice if places would do that, you'd have a much happier working environment.

**AC:** ...because you are working in this little control room and if you can't get along with the person beside you, it's miserable...so they know that person fits in their culture, which (*when*) you're pulling somebody off in an interview, you don't know.

AC comments on how graduate practitioners quickly become accustomed to the culture of her organisation because they were placed in that department during their undergraduate programme. This provides an opportunity for the potential employer and the employee to see how well they fit into the department and how proficient the employee is in MRI. This results in high levels of job satisfaction and a happy working environment, which is especially important in the small confines of the MRI control room.

#### 5.3.5.3. Remuneration

**INTERVIEWER:** Do you pay them differently? I mean, if you were to take you know, one from each group.....do they end up having the same salary or is the primary pathway person (*graduate practitioner*) paid less?

**CMUSA:** Actually they are paid more.....we have now regulations that if we want to be accredited, all of staff need to be registered or certified ...and because they (*graduate practitioners*) are registered, they would get paid more than the RT (*experiential practitioner*)...

**EXP1:** ...bang for buck there's not many bachelor's programmes that you can get right out of the programme without knowing anybody and have the earning capacity that you do in MRI.

**GRAD2:** ...but I am extremely happy with the role I am in at this institution at this point...it pays well enough...I mean, I am comfortable.

Three respondents give different perspectives on this issue. CMUSA states that in her experience, graduate practitioners are likely to be paid more than experiential practitioners if the only differentiator is certification in MRI. This is because undergraduate programmes specifically train practitioners to pass the ARRT certification examination and those who have done this tend to attract higher

salaries than those who are not certified. This view is confirmed by EXP1 and GRAD2.

#### 5.3.5.4. Scope of practice

**EXP1:** I like a mix of the hands on, the application, the training and then more creative projects creating inspirational presentations...I get that mix so I like that, because I would get bored if all I did was scan.

**CMUSA:** I think that depends on the individual. I think that everybody is different and I use that based on my own experience. When you do MR repeatedly and all you do, let's say, (is) lumbar (spinal MRI examinations) all day and you are sitting there waiting for, you know, four minutes for a sequence to pass, you kind of get bored with doing the same thing...So, for me it was good to have the variations.

Scope of practice is a significant theme and is explored in detail in Section 5.3.4. The following relates specifically to how this theme may impact upon job satisfaction. Two respondents give different perspectives on this issue, which appear to reflect their own scope of practice. For example, EXP1 who, although a generalist, has spent most of his career working in MRI only believes that focusing on a discrete area of practice has given him the opportunity to teach MRI, but he admits that he would get bored if all he did was scan. CMUSA believes that this is an individual preference but that it could have a significant impact on their enjoyment of their job.

#### 5.3.6. Professional resistance

**GRAD2:** I haven't seen it (*professional resistance*) so much here but in experiences I've had at other hospitals, I have seen a real shunning of sorts.

**GRAD2:** ...there is a large, very large hospital on the other side of town and they have a radiologist who says he doesn't want any MR tech that doesn't have X-ray training (*graduate practitioner*). So, I will never work there.

**GRAD1:** one tech (*experiential practitioner*), I think she knows (*that I know more*) but she doesn't want to admit it...

**CMUSA:** I think they did (*treat graduate practitioners differently*) at the outset, but that's changing....I think it got to a point where they had to prove themselves and we're past that now.

**CMUK:** it (*the introduction of assistant practitioners*) was embraced by some of the radiographers...it was met with derision by a number, I think, because it's always a divisive thing, it's a bit like Marmite, some radiographers were sceptical and basically said, "Oh, cheap radiographer labour, you're replacing radiographers", that sort of thing.

This theme emerges from responses to questions relating to the drawbacks of employing graduate practitioners and four respondents refer to it. GRAD1 and GRAD2 were asked about their experiences in terms of their acceptance within the

workplace by their peers. GRAD2 comments on how, in some hospitals, he was shunned by his peers. He also makes a reference to radiologists and the fact that although he is treated in the same way as an experiential practitioner in the hospital he currently works in, there is significant resistance from a radiologist in another hospital.

GRAD1 comments on her level of knowledge compared with that of a certain experiential practitioner. The practitioner knows that she (the respondent) is more knowledgeable but doesn't admit it. Evidence of professional resistance is substantiated to some degree by CMUSA and CMUK. CMUSA reports initial resistance to graduate practitioners but says that this is changing because graduate practitioners are 'proving their worth'. CMUK makes similar comments about resistance to the introduction of assistant practitioners who are trained in MRI in her department, but does not comment on this changing.

### 5.3.7. Registration

**AC:** ...I took the Registry (*the ARRT certification examination*) because that was the only one I could take at the time, because the ARRT wouldn't let me in because I was a nuclear medicine technologist and not an X-ray technologist...

**EXP1:** ...they've (*the ARRT*) lifted that (*a requirement to be a radiographer*) now and part of it isn't just because out of the kindness of their heart, part of it is because of the ARMRT (*American Registry of MRI Technologists*), they started pushing the schools for just MRI... So, I mean, you are seeing more and more that you don't have to be an X-ray tech...

**EXP1:** The hardest time I had with that initially, back in the 90s, was you had to have your X-ray licence (*be previously certified as a radiographer*) first for the ARRT, which is ridiculous. Why, tell me why, there's no ionising radiation, why is it a requirement?

**CMUSA:** Prior to new regulations, we would hire a student graduate who was not registered. OK, we have now regulations that if we want to be accredited, all of staff need to be registered or certified with the board (*ARRT*)...

**CMUSA:** ...and because they are registered, they would get paid more than the RT (*experiential practitioner*) coming across.

Six respondents refer to the theme of registration. Respondents in the USA were questioned about how registration barriers were overcome in the USA. AC and EXP1 provide a useful historical perspective. EXP1 reports that an organisation called the American Registry of MRI Technologists (ARMRT) was a driving force behind the development of undergraduate programmes in MRI and the registration of graduate practitioners. This forced the ARRT into also allowing non-radiographers to take their registry examinations in MRI, and this is now a requirement in many (but not all) states. In the experiences of EXP1, AC and

CMUSA, it is now a requirement that anyone practising MRI in their states must possess the ARRT certification in MRI.

Some key points are made by AC and CMUSA in this discussion. Graduate practitioners who are not registered with the ARRT are still employed. This indicates that service users and registering bodies are influential agencies in registration. CMUSA also raises a further point, which is that graduate practitioners who have the ARRT registration are paid a higher salary than experiential practitioners who are not registered. This theme is also raised with respect to job satisfaction (see Section 5.3.5.4.). GRAD1 says that undergraduate studies prepared her for the ARRT registry examination.

**GRAD1:** Even talking with the other techs, like preparing for the registration, oh it was so hard... I've studied really hard for it but I thought it was relatively easy compared to my studies and the tests I took in class...

CMUK and COR were questioned to gain a UK perspective on registration issues. CMUK discusses what she feels are the benefits of registration to patients and employers. These reflect that registration implies a standard of training and competency. She was then questioned further about whether she would employ unregistered graduate practitioners. She draws upon her experience of employing assistant practitioners, who are not registered radiographers but who have undertaken a foundation certificate in MRI. Although assistant practitioners are not registered, their qualification in MRI is made known to service users and appropriate training is a more important factor than registration. She also refers to the professional body and her expectations of its role in overcoming registration barriers.

**CMUK:** It's like a stamp, it's like a standard. ...It provides assurances to our customers and our service users that the radiographers are all... registered.... It's a requirement because it shows a level of competency that's been earned.

**CMUK:** ...so I'd probably say as long as it (*undergraduate programme in MRI*) was a recognised formalised pathway, as long as it attained a certain level of clinical expertise, I don't think I would not, not take somebody on (*who wasn't registered*).

**CMUK:** ...so, that's what I would look for would be our next professional regulatory body or the society or whatever it may be or the Royal College of Radiologists, as long as it (*undergraduate programme in MRI*) was recognised as a course by them that you had attained a specific level of expertise, I don't think I'd have a problem with it (*employing unregistered graduate practitioners*).

COR provides some insights into registration in the UK. She states that she supports registration of radiographers because it safeguards the public, and she implies that registration is a criterion of a professional. In the context of radiography, this considered to be more relevant than protecting the public from ionising radiation. She makes the point that the government is seeking to reduce the number of registrable professions, rather than increase them to include specialist practitioners. She explains the rationale behind this and says that, although registering graduate practitioners may not be a problem, the UK professional body sees MRI as part of the core role of a radiographer.

**COR:** I would look at it that actually doctors and nurses are registered, dentists are registered, all the other allied health professionals that work in the health service are registered, so it's not to do with the ionising radiation per se, it's to do with professional practice.

**COR:** Also, they (*graduate practitioners*) couldn't be regulated unless they were actually, they were being called radiographers, which again is that issue with safeguarding the public and again getting new names on the register, we know is not likely to happen.

**COR:** I wouldn't see a problem with them being registered. The problem is in the logistics of getting any more professions on to the register and actually, MRI I see as part of the core role of the radiographer, so... I don't see the HCPC looking to register a small part of that section of that profession that exists already, whereas ultrasound is slightly different because of ...the breadth of the professionals who've actually started to use that technology or are using those technologies.

COR explains that currently, sonographers (practitioners who perform ultrasound scans) can be placed on a voluntary register if they wish. However, the UK professional body representative sees them as different from MRI graduate practitioners because unregistered practitioners are already practising ultrasound, and this might be justification to develop a strategy to register sonographers. However, this statement does not appear to recognise that there are also unregistered practitioners in MRI, including assistant practitioners, and that a similar registration strategy may therefore be necessary.

**COR:** So we have a voluntary register for sonographers and anyone who's practising as a sonographer is welcome...it's not a legal requirement and we have that set up so that really we are then offering some protection to the public but actually as a professional body, it's almost at odds with protecting the public, because we're protecting our members. So, it's not the best mechanism.... So, ideally you need it to be separate from the professional body...we review that register and those on it but the legal obligations are not the same...

**COR:** Well, the challenge for ultrasound is we know there are professionals who enter ultrasound from many different routes and I think it's a slightly different issue because we know we can't attract enough; it's grown out of all propensity and so we need quite a urgent solution to that and because we have a lot of professionals who are not registered

at the moment, there are various different bodies obviously involved in the discussion around the future ultrasound workforce, and so I think it has to be something we work at together with those bodies, whereas a lot of the other areas are areas that we've traditionally been within our scope.

**COR:** We have a voluntary register, so we have had to adapt and develop a certain mechanism for that and clearly the assistant practitioners work under the supervision, direct or indirect, of a registered practitioner and that is their level of practice, and I would never ever see them and we wouldn't be going higher, although it's often mooted that actually, they can do this, they can work at a higher level, actually not because that's the registered level. So, we are strong believers and support registration.

### 5.3.8. Summary

A summary of the qualitative findings of this study is provided in Table 5.21.

Table 5.21. (p.186) shows that according to the views expressed by interview participants in this study, there are several benefits of and barriers to graduate practitioners. The benefits of graduate practitioners lie mainly around their high levels of knowledge of MRI, resulting in improved patient throughput, better patient safety, reduced training costs and reduced scanner downtime. There also appears to be a high level of job satisfaction. The barriers emphasise the limited scope of practice of graduate practitioners, the potential for professional divisions and the problem of registration of non-radiographers in the UK.

In the next chapter the quantitative and qualitative findings are analysed and interpreted to specifically address the research questions.



**Table 5.21. Summary of qualitative findings**

Parent node	Child node	Benefit	Barrier
<b>Patient care</b>	Handling skills		Students have fewer skills than qualified radiographers
	Patient safety	Increased patient safety	
	Protocol efficiency	Improved patient experience	
<b>Costs</b>	Departmental efficiency	Up patient throughput Reduced recall rates Less training needed Increased staff retention	
	Scanner down time	Less downtime Less use of engineer	
	Salary costs		Higher compared with non-registered practitioners
<b>Scope of practice</b>	Lack of modality skills		Cannot perform Waters' view Limited rostering
	Employability	Improved competency	Reduced flexibility
	Focused knowledge	Improved patient care More opportunity for teaching	Limited understanding of wider modalities
<b>Job satisfaction</b>	Focused knowledge	Increased status Improved patient care	
	Organisational fit	Improved if graduate is in same clinical placement when a student More professional	
	Remuneration	Valued staff member	
	Scope of practice		Boredom Limited marketability
<b>Professional resistance</b>			Divisive professional relationships
<b>Registration</b>		USA: curricula designed to ARRT registry exam so registration easier	UK: COR sees MRI as a core radiographic skill UK: de-regulation

## CHAPTER 6: DISCUSSION

## 6.1. INTRODUCTION

The purpose of this chapter is to provide a detailed analysis and interpretation of the findings of my research. This involves stepping back from the results presented in Chapter 5 and exploring what they mean. The overall aim is to investigate to what extent the quantitative, qualitative and mixed-methodology research questions are addressed by my research. The goal is to assess whether an undergraduate degree that leads to direct entry into practice is a beneficial way of educating MRI practitioners. This is based on the proposition that the practice of MRI reflects a different kind of knowledge from that of general radiography, and that undergraduate curricula best align with the skills and competencies required of an MRI practitioner who first enters practice.

In mixed-methodology research, decisions on when and how to integrate data are important. Bazeley (2009) advocates several phases that are congruent with a convergent nested design. These involve an independent analysis of both types of data, followed by a decision on how the findings are merged or connected. Creswell and Plano Clark (2011) recommend comparative strategies when the data are collected concurrently and analysed separately. As the purpose of this research is to compare the quantitative and qualitative findings, I have chosen this technique. This involves looking across the findings, making links and connections between them and then assessing how the information gleaned from this process addresses the mixed-methodology research question (Onwuegbuzie and Teddlie, 2003).

The key outcomes of both types of data are linked using the connections matrix explained and justified in Chapter 4 (see Table 4.8., p.132). After this, a discussion based on the connected results is provided to examine the educational and professional aspects of early specialisation in MRI. Finally, the validity, reproducibility and generalisability of the findings of this research are explored.

## 6.2. ANALYSIS OF THE EDUCATIONAL, QUANTITATIVE FINDINGS

Rigorous scrutiny of quantitative data involves comparing the results of the statistical analysis with the research question and the literature to determine how well this question and the hypothesis are answered (Creswell and Plano Clark, 2011). The educational, quantitative research question identified in Chapter 3 is:

*What is the relationship between the educational level at which a practitioner learns MRI and their residual knowledge of MRI theory?*

The hypothesis explained in Chapter 4 and tested in Chapter 5 is:

*Graduate practitioners have more residual knowledge of MRI theory than experiential practitioners.*

As discussed in Section 4.2.4., I define residual knowledge as working knowledge that is applied to practice, which is different from knowledge that has been recently acquired or memorised for an examination. The importance of applying knowledge to practice is well recognised in clinical education (Benner, 1984; Baxter, 2007; Gillespie and Paterson, 2009). Health practitioners need to learn how to perform task-orientated procedures by making informed decisions based upon a sound knowledge of theory. This requires deep learning and the ability to connect theoretical principles with practice (Tanner, 2010). Working knowledge as applied to practice, therefore, is more valuable than knowledge acquired by rote: in the context of MRI, this is likely to be the type of knowledge that a practitioner draws on to scan patients. The amount of residual knowledge of each participant in each topic in the OSCE was measured via the number of questions answered correctly. The number of incorrect answers and unanswered questions reflects what each participant either thought they could answer but did not answer correctly or knew they could not answer. The participants were carefully selected so that the only difference between them was how they learned MRI. Participants in both groups were graduates (in either MRI or radiography) but they learned MRI differently. These distinctions were made to investigate any relationship between experiential and undergraduate learning and residual knowledge. Comparisons with other types

of learning (postgraduate, for example) may be important but were excluded to delimit this research.

Interrogation of the quantitative data and correlation with key literature sheds light on the comparative residual knowledge of the graduate and experiential practitioners in my research. As discussed in Chapter 2, only two previous studies assessed the knowledge of a group of MRI practitioners using an OSCE.

Westbrook and Talbot (2009) tested 47 MRI practitioners, all of whom had previously qualified as radiographers. Data were not collected on how they had learned MRI but, as the most common route is experiential learning (Castillo et al., 2016), this is presumed to be the case for most of these participants. With the exception of Section 4, the OSCE questions used by Westbrook and Talbot are identical to those used in this research, so their findings are a useful comparator with the OSCE scores of the experiential practitioners in this study.

Weening, Gilman and Greenidge (2012) also used OSCE data to measure the first-time failure rates of a large group of MRI practitioners who had completed the ARRT certification examination in MRI. Although the OSCE questions used in my research are referenced from a database of questions developed for this examination, the questions and section headings are not the same. Weening, Gilman and Greenidge (2012) compared failure rates rather than category section scores, and they did not differentiate between graduate and experiential practitioners as I have defined them. However, they did compare failure rates between practitioners who had and had not completed some form of undergraduate MRI programme prior to the examination. Therefore, they could measure the impact of a formal undergraduate MRI programme. Consequently, it is possible to refer to their research in places in this discussion.

The descriptive statistical analysis of the quantitative data illustrated in Chapter 5 shows higher total OSCE scores and mean scores in the graduate group in all five sections and, therefore, in the OSCE overall. In addition, a higher percentage of questions is left unanswered by experiential practitioners in all five sections (see Table 5.3., p.155). The results of Weening, Gilman and Greenidge (2012) support these findings, with practitioners who have completed an undergraduate programme in MRI being over one and a half times more likely to pass the ARRT MRI examination than those who have not. Furthermore, my research suggests that there is a difference in the consistency of knowledge between the two groups. The

highest total score of an individual in each group is similar, but the lowest scores are very different (see Table 5.1., p.143). Further analysis of the raw data shows that 30% (7/23) of the experiential practitioners score lower than the lowest score in the graduate group. Because of the different ranges of scores in this study (graduate=38%, experiential=69%), there is a corresponding difference in the standard deviation and variance between each group; however, Levene's test shows that for statistical analysis they can be treated as similar. The findings that refer to experiential practitioner scores are comparable with those of Westbrook and Talbot (2009), where the range of scores attained by their assumed experiential practitioner participants is 58%. These corroborative findings might indicate that experiential practitioners have a less consistent level of knowledge than graduate practitioners. The experiential group's OSCE scores suggest a wide variety in level of knowledge and may reflect the more disparate way in which they have learned MRI.

Inferential statistical analysis is strongly corroborative. In the two-tailed t-test, the total OSCE score in the graduate group is greater than that of the experiential group, with a very high level of statistical significance (0.0188,  $p < 0.05$ ). The Cohen's effect size calculations show that the educational level at which MRI is learned has a large impact on the residual knowledge of MRI (see Table 5.19., p.164). Sections 2, 3 and 4 of the OSCE are responsible for this significance, with Section 2 (general principles of MRI) mainly accounting for the highly significant result (0.0014,  $p < 0.05$ ). This is reflected in Figures 5.1. and 5.2. (pp.141-142), which illustrate a difference in scores in this section. There is also a correspondingly very large Cohen's effect size (0.971), which shows that the effect being tested (the specialised undergraduate degree in MRI) does have an impact on the OSCE score with respect to the general principles of MRI. The chi-square test reveals that the observed OSCE scores are not statistically different from those that one would expect by chance. This is especially evident in the sections with a high t-test significance (Sections, 2, 3 and 4). However, because the overall scores are different to such a high level of probability, it seems unlikely that they are affected by chance alone. The undergraduate degree in MRI appears to have a notable influence on the results. A more detailed analysis of each section of the OSCE is now provided to draw the reader's attention to the most important findings.

### 6.2.1. Sectional analysis

In Section 1 of the OSCE, participants were required to identify commonly imaged pathologies using MRI and major anatomical structures (brain, knee and spine). They were also asked questions about MRI safety. Encouragingly, the OSCE scores in these subjects are high in both groups, accounting for no statistically significant difference between them. However, there are examples of several participants in both groups leaving questions that refer to basic understanding of anatomy and pathology unanswered (see Figure 5.10., p.150 and Table 5.4., p.155). In the experiential group, questions requiring participants to label the main structures in the brain, spine and knee (questions 12–16) are left unanswered more often than other questions in Section 1. Similar results are reported by Westbrook and Talbot (2009), with mean scores of 43.5% and 57% for anatomy and pathology respectively, implying that learning these subjects is particularly problematic for experiential learners. However, examples can also be found of graduate practitioners leaving anatomy and pathology questions unanswered in my research. For example, question 12 (which required participants to recognise a common spinal pathology) is left unanswered by nearly one-third of the graduate group.

Knowledge of anatomy and pathology is necessary to enable practitioners to apply scan slices to the correct area for imaging and use appropriate slice orientation. These skills are required so that every patient is imaged accurately (Skills for Health, 2008). The apparent lack of knowledge in these subjects amongst participants in this study is, therefore, concerning. Graduate and experiential practitioners should learn anatomy and pathology as part of either an MRI or a radiography undergraduate curriculum (Pratt and Adams, 2003; Weening, 2012). Therefore, it is surprising that some answers show that participants in both groups are unable to label basic structures and identify the commonest examples of pathology that they should see in everyday practice. These results raise questions about how anatomy and pathology are taught, learned and assessed on undergraduate programmes. Perhaps neither educational route permits the application of this knowledge to practice, or perhaps knowledge of anatomy and pathology is lost post-qualification.

Section 1 also assesses each participant's knowledge of MRI safety. This is a vital subject, especially regarding who is contraindicated for MRI and, therefore, should

be excluded from the strong magnetic field of the scanner. Although most questions are answered correctly by participants in both groups, there are some points to note. Firstly, the findings that relate to knowledge of contraindications to MRI (questions 1–4) are similar to those in the earlier research of Westbrook and Talbot (2009). Both studies include the same questions; therefore, a useful comparison is possible. Westbrook and Talbot found that 42% of their participants could not identify all four contraindications to MRI from a list of 19 possibilities (of which only four were correct). In this research, 40% of graduate practitioners (10/25) and 42% of experiential practitioners (10/23) cannot identify the same four contraindications from the same list.

Secondly, questions 9 and 10 are not answered or are answered incorrectly by numerous participants in both groups (see Table 5.4., p.155). These questions refer to two reasons why it might be contraindicated to scan a patient when the patient had been scanned safely at another facility on the previous day. Thirty-nine per cent of the experiential group and 32% of the graduate group correctly identify that the field strength of the scanner might be higher than that of the scanner at the other facility. However, no one in either group identifies that if the patient is female, she might have had a positive pregnancy test between the two scans and, therefore, she might be contraindicated for MRI. Westbrook and Talbot (2009) support this finding with similar results for the same questions in their study. These questions are deliberately obscure (as this scenario is not likely to represent a situation that would be presented to a practitioner on a regular basis), but they were included to assess each participant's ability to solve unusual problems. It might be expected that practitioners in the experiential group, who have, on average, over twice as much experience in MRI than those in the graduate group, would score more highly in these questions, as they are more likely to have come across this problem in practice. However, this does not appear to be the case. As the scenario posed by this question is uncommon, these findings are not particularly worrying, but they may indicate that there is room for improvement in developing the skills needed to solve unusual problems in both educational models. However, the lack of knowledge of the contraindications to MRI amongst a significant percentage of the MRI practitioners in both groups is of concern, especially because the finding is supported by previous research. These results imply that neither educational model is reinforcing this knowledge, leaving open the possibility for unsafe practice.



Sections 2, 3 and 4 account for the highly significant difference in scores between the two groups. In particular, Section 2 is responsible for the statistically significant result and relates to a participant's understanding of the general principles of MRI. The percentage of questions left unanswered is similar in both groups (see Figure 5.11., p.151), so the significant result is due to the difference between the percentage of correct and incorrect answers in each group. The difference between the graduate and experiential scores indicates that the general principles that underpin MRI appear to be the key differentiators of residual knowledge. In the same subject, the largely experiential participant group in the research of Westbrook and Talbot (2009) achieved a similar mean score to that of the experiential practitioners in my research, which might indicate that learning the general principles of MRI is especially challenging for this group. It is perhaps not surprising that graduate practitioners achieve a higher score, given that this subject is part of the undergraduate curriculum. However, it is important that all MRI practitioners (including experiential practitioners) have a good grasp of general principles, as they support understanding of other topics. In this study, it is possible that a lack of knowledge of this subject is one of the reasons why experiential practitioners do not score as highly as graduate practitioners in all the other sections of the OSCE. This emphasises the importance of learning MRI from a curriculum in which teaching and learning general principles is a key feature. Having said this, questions 24 to 26 in this section are left unanswered more frequently than the other questions in this section by participants in both groups (see Table 5.4., p.155). This indicates that for some topics, neither educational model is beneficial.

Section 3 relates to an MRI practitioner's ability to identify the various contrasts seen in MR images. This is important knowledge, as it affects how well pathologies are visualised and diagnosed. Graduate practitioners' scores are higher than those of experiential practitioners in this section, with graduate practitioners achieving a higher mean score (see Figure 5.8., p.148). Although correct answers are provided for all 20 questions in this section by one experiential practitioner (the only instance of a 20/20 section mark in the data), the standard deviation and variance is the highest of all five sections in the experiential group (see Figures 5.9. and 5.10., pp.149-150). This suggests that the knowledge of experiential practitioners is more varied in this subject than in any other in the OSCE. Questions 50 and 51, which require participants to define and give an example of a parameter that internally affects image contrast, are not answered by just over half (52%) of experiential

practitioners (see Figure 5.13., p.153 and Table 5.4., p.155). Similar results for the same questions (49%) are reported by Westbrook and Talbot (2009) amongst the assumed experiential practitioner participants in their study. These corroborative findings imply that experiential practitioners might not be as conversant with certain terms and definitions as graduate practitioners. This is perhaps not surprising, given that they learned MRI in an informal way.

The OSCE questions in Section 4 are designed to test each participant's knowledge of how images are acquired. This knowledge is important, as it enables practitioners to understand how their choices of scan parameters affect the resultant images in terms of contrast and quality. The statistical difference is accounted for by graduate practitioners out-performing experiential participants in this subject. In the experiential group, fewer questions are answered correctly and more questions are answered incorrectly in this section, and a higher percentage of questions is left unanswered (see Table 5.3., p.155). One participant in the experiential group achieved a score of zero in Section 4: the only instance of a zero section score in the data. Questions 76 and 77 are left unanswered by several experiential practitioners (see Figure 5.13., p.153 and Table 5.4., p.155). These are quite technical questions, which refer to subjects that are included in the undergraduate curriculum; therefore, it is not particularly surprising that graduate practitioners score more highly. However, Section 4 is different, because it is the only section for which the standard deviation and variance are highest in the graduate group (see Figures 5.9. and 5.10., pp.149-150). Nonetheless, the difference is minimal, indicating that there is little difference in variability between the two groups. This raises questions about how image production is taught and assessed in undergraduate programmes and how curricula enable the application of knowledge to practice in this subject.

Section 5 (image optimisation) relates to image quality and how protocols are optimised. A fundamental skill of an MRI practitioner is the ability to challenge pre-defined protocols and modify parameters within each protocol so that they are optimised in terms of image quality and scan time (Westbrook, 2014). Although graduate practitioners score higher in this section, there is no statistically significant difference between the scores. In this section, fewer questions are answered correctly and more questions are answered incorrectly by both groups than in any other section of the OSCE, and a higher percentage of questions is left unanswered by both groups (see Table 5.3., p.155). The questions most often left unanswered

by both groups of practitioners relate to understanding the consequences of altering certain protocol parameters (questions 81–84 and 95–98; see Figure 5.14., p.154 and Table 5.4., p.155). Whilst some answers are provided by most practitioners, none of the answers lists all the consequences, and one graduate and four experiential practitioners could not provide any correct answers. Westbrook and Talbot (2009) used the same questions and also found that this was the section in which their participants performed worst, with no one scoring more than 40%. Further analysis of the data in the present research shows that 43% (10/23) of the experiential practitioners score less than 40% in Section 5. However, in the graduate group, the results are better, with only 24% (6/25) scoring less than 40%. This might indicate that the undergraduate MRI programme has more impact than experiential learning on the acquisition and application of knowledge of image optimisation, but this is balanced by the relatively low scores of both groups in this section. Neither educational model appears to permit a deep understanding of scanning parameters, why they are selected and the consequences of changing them.

Despite some examples where neither educational model might be benefiting learners, overall the quantitative findings support the hypothesis that graduate practitioners have more residual knowledge of MRI than experiential practitioners have. Table 6.1. (p.197) is derived from Table 4.8. (p.132) and links the educational, quantitative research question with a variety of possible outcomes. This framework shows that the quantitative findings support the view that a specialised undergraduate degree in MRI is a more effective way of learning MRI than experiential methods, because the OSCE scores of graduate practitioners are higher than those of experiential practitioners in all five sections of the OSCE (green shading).

**Table 6.1. Educational strand matrix**

Research question	Graduate practitioner OSCE score	Experiential practitioner OSCE score	Possible outcome
What is the relationship between the educational level at which a practitioner learns MRI and their residual knowledge of MRI theory?	High	Low	A specialised undergraduate degree may be a more effective way of learning MRI.
	Low	High	Experiential learning after qualification as a radiographer may be a more effective way of learning MRI.
	Same/similar	Same/similar	How MRI is learned may have no significant effect on a practitioner's knowledge of MRI. Further research is needed.

## 6.3. INTERPRETATION OF THE PROFESSIONAL, QUALITATIVE FINDINGS

Interpretation of qualitative data involves comparing the evaluation of interview responses with the research question and the literature to determine how well this question is answered. A personal assessment of the meanings of the findings is also permitted, because qualitative research accepts that interpretations can never be separated from the researcher's own views (Creswell and Plano Clark, 2011).

The professional, qualitative research question identified in Chapter 3 is:

*What are the professional benefits of, and barriers to, early specialisation in MRI?*

The purpose of this strand of the study is to explore the professional perspectives of early specialisation, but several educationally related themes also emerge. These refer to how knowledge affects the skills and competencies of a practitioner and how these have an impact on the practices expected of a professional. The educational and professional threads of the qualitative data, and correlation with relevant literature, are used to support the quantitative findings of this study with a view to ultimately investigating the feasibility of introducing an undergraduate MRI programme in the UK.

As discussed in Chapter 2, there are two studies on specialist practice in radiography: one by Ferris (2009) and one by White and McKay (2004). Ferris (2009) explores radiographers' perceptions of specialism via semi-structured interviews. This article enabled me to identify the key themes used in the development of the interview questions; therefore, it provides a useful frame of reference for my qualitative research findings. White and McKay (2004) investigated a variety of issues surrounding specialisation across healthcare professions, including radiography, and their study is also a useful comparator. Therefore, the qualitative research findings are triangulated with this literature where possible; however, they are also supported by other relevant research.

### 6.3.1. Benefits of early specialisation

Many of the respondents emphasise the value of specialisation in the discrete area of practice of MRI. They make distinctions between the knowledge and skills of graduate and experiential practitioners. According to some of the respondents, the benefits of employing graduate practitioners lie mainly in their higher levels of knowledge, which results in improved patient experience, reduced patient-recall rates and improved patient safety (see Section 5.3.2.). These opinions are similar to those in the research by Ferris (2009), who also use the responses of a group of practitioners to explore specialisation in radiography. Ferris (2009) cites examples where specialist practice is clearly linked to being knowledgeable in a particular field of expertise. Other authors also refer to the benefits that highly specialised and knowledgeable practitioners bring to patients. The ability of a knowledgeably critical practitioner to follow evidence-based guidelines results in improved trust and confidence (Footner, 1998).

Departmental cost-benefits are also identified by three of the respondents and include improved patient throughput, reduced training costs and less scanner downtime (see Section 5.3.3.). It seems that sometimes experiential practitioners need costlier and lengthier MRI training than graduate practitioners, because they have not previously learned MRI. The difference between graduate and experiential practitioners' training needs post-qualification is understood in terms of not only the cost but also how long it takes for the value of each practitioner to be realised. For example, experiential practitioners cannot necessarily be used to cover leave or placed on-call on an equal footing with their fully trained graduate colleagues until they are competent in all types of MRI examination. This view is corroborated by Stover (2011), who reports similar cost-benefits in employing non-nurse midwives.

A common theme in the interview responses is graduate practitioners' increased ability to change and modify scan protocols, which results in improved image quality and a more cost- and time-efficient service. Based on the qualitative data, graduate practitioners appear to sometimes out-perform experiential practitioners in this area of practice. According to half of the respondents, experiential practitioners, who may lack knowledge and understanding of protocol parameters and the effect they have on image quality, are more likely to produce undiagnostic images, which results in patients being recalled for repeat scans (see Sections 5.3.2.3. and

5.3.3.2.). This is not only inconvenient for the patient but also impacts on department efficiency and patient throughput. This view is supported by Caruana and Plasek (2006), who warn that a lack of knowledge of MRI physics and how this knowledge is applied has led to numerous instances of incorrect use of the scanner. Some respondents believe that graduate practitioners are more capable of applying their knowledge of image optimisation, which leads to better image quality and more thorough examinations. A surprising finding of this research is that, according to two respondents in this study, some experiential practitioners are more likely to not only produce sub-optimal images but also blame poor image quality on the equipment rather than on their incorrect setting of protocol parameters. This can result in an engineer being called to diagnose a non-existent fault, which impacts on departmental efficiency and patient throughput (see Section 5.3.3.2).

The possible consequences of knowledge and skills on patient safety are evident in three of the interview responses. One respondent uses the word 'scary' when referring to the safety skills of experiential practitioners (see Section 5.3.2.2.). The undergraduate MRI curriculum places a great deal of emphasis on MRI safety and requires that students maintain a logbook of examinations and patient-safety information. Therefore, it is perhaps not surprising that graduate practitioners may have more knowledge of MRI safety than experiential practitioners. These findings are supported by Weening (2012), whose interview data from several MRI educators in the USA suggests that to ensure patient safety, it is important that MRI practitioners attain an undergraduate qualification in MRI before they practise. These findings also raise the question of who is responsible for the safe practice of imaging professionals. The respondent who uses the word 'scary' when referring to experiential practitioners is an academic and therefore not directly responsible for the safe practice of these individuals. However, another of the respondents is an experiential practitioner and refers to the specialisation of graduate practitioners leading to safer practice. The SCoR code of conduct (SCoR, 2013d) states that radiographers "must practice within the limits of their competence and develop and maintain competence through continuing professional development" (2.2 and 2.4). The responsibility lies with the practitioner to ensure that they are knowledgeable enough to practise competently within their scope of practice. However, clinical managers also share this responsibility, particularly in ensuring that all staff are trained and up to date. The implication by three of the respondents in this study that some experiential practitioners may not be safe to practice is noteworthy and this

finding is corroborated by Westbrook and Talbot (2009) and Weening (2012) who raise similar concerns.

The professional benefits of improved knowledge of MRI amongst graduate practitioners also emerges from accounts of job satisfaction, staff retention and remuneration (see Section 5.3.5.). Four of the interviewees in this study indicate that having the knowledge and skills to perform a job well improves professional status and increases a practitioner's enjoyment of their job. It also leads to higher salaries in some cases. This view is supported by Ferris (2009) and White and McKay (2004), who evidence improved job satisfaction amongst practitioners who have specialised knowledge and skills. It is also clear from some of the interview responses that educational provision has been pivotal in allowing some graduate practitioners to gain a foothold in MRI practice. Graduate practitioners also link their in-depth knowledge of MRI with a more rewarding experience in terms of how they can improve patient diagnosis and the patient experience in general. Job satisfaction appears to improve staff retention, possibly leading to a more stable workforce.

There are, however, some conflicting views on the competencies of graduate and experiential practitioners. Two respondents highlight a lack of competence in patient-handling skills amongst graduate practitioners, but further questioning reveals that this is only when comparing them with qualified radiographers, who learn these skills via the undergraduate degree in radiography (see Section 5.3.2.1.). When a like-for-like comparison is made between radiography and MRI students there are no reported differences, and two of the respondents believe that non-radiographic practitioners have the best handling skills. As these skills are taught on the undergraduate radiography and MRI programmes, in theory there should be no difference between the two groups. The conflicting views might be due to the respondents' different lived experiences of undergraduates in radiography and MRI. They may also reflect students' different attitudes towards their patients rather than reflecting the way in which they were educated.

Finally, there are consistently held views that graduate practitioners fit well into the departmental organisation and that, for the most part, there is no reported resistance or professional jealousy (see Section 5.3.6.). The graduate practitioners interviewed in this research appear to work seamlessly alongside their experiential practitioner colleagues. Similar acceptance of direct-entry practitioners by their



more traditionally educated colleagues is also reported in midwifery (Davis-Floyd, 1999; Stover, 2011). This may be because all the participants interviewed in the USA work in departments where graduate practitioners had undertaken their clinical preceptorships as students and, therefore, they were familiar with the culture of the department. The only respondent who expresses resistance to early specialisation is the representative of the UK professional body. This is perhaps expected, given that her responses reflect the policy of the radiographic professional body, which sees MRI practice as a core skill of a radiographer (SCoR, 2013a). The UK clinical manager, however, is very supportive of early specialisation in MRI. This difference in opinion between the UK professional body representative and a UK clinical manager interviewed in this study might reveal potential tensions between what employers want from their employees and how the professional body defines the skills of a radiographer. However, further research is needed to capture other views from NHS managers and the private sector.

### 6.3.2. Barriers to early specialisation

A recurrent theme in the qualitative data is the inability of graduate practitioners to work in other areas of an imaging department. Although the value of specialisation is recognised, this is balanced by the restricted practice and employability of graduate practitioners (see Section 5.3.4.). These views are echoed in the literature, with consistent warnings about the lack of flexibility and transferability of specialist skills (White and McKay 2004; Martin, Currie and Finn, 2009; Rosser, 2015). However, the interview responses add further clarification by suggesting that the limited scope of practice is dependent on the size and location of the imaging department. All the clinical respondents in my research work in large hospitals and imaging departments with high staffing levels. In this environment, the limited scope of practice of graduate practitioners does not seem to be realised. There appears to be a very high demand for MRI scans; therefore, graduate practitioners are rarely required to work in other modalities. However, this may not always be the case in smaller departments, or on mobile MRI scanners, where a limited number of staff are employed. In these types of working environments, transferrable skills are likely to be important. For example, in a small department with a limited number of staff an MRI practitioner might be required to cover employees who are on leave or be placed on-call in modalities other than MRI.

An MRI practitioner might also sometimes be needed to perform X-rays as part of the MRI screening procedure. Patients who have a history of injury to the eye are potentially contraindicated for MRI, because any metal fragments in the eye might be moved by the scanner's magnetic field and cause significant injury, including blindness (Shellock and Cruess, 2013). These patients require screening via either an X-ray of the eyes (called Waters' view) or a CT scan (which also uses X-rays). In large departments, these can usually be performed by practitioners who work in these modalities. In smaller departments, this may not be possible; therefore, the inability of a graduate practitioner to perform these screening examinations is potentially problematic. A solution might be to include MRI screening techniques in the undergraduate MRI curriculum, but this would still not permit graduate practitioners to work on a regular basis in X-ray modalities.

Due to strong magnetic fields, the MRI department is commonly located remotely from the main imaging department. Therefore, even in smaller departments, MRI

practitioners are often not able to cover other modalities because they are located too far away for it to be practical. An unexpected finding of my research is that according to three respondents in this study although in theory experiential practitioners are generalists, if they have specialised in MRI for a long time they, too, become deskilled in other modalities. This results in them having the same limited scope of practice and inflexibility as their graduate practitioner colleagues. This might be a significant issue, as it could have an impact on how imaging departments are staffed and how imaging practitioners are trained. According to some of the interview responses, unless practitioners work in an area of practice on a consistent basis they lose knowledge and skills, regardless of the way in which they were educated. Therefore, although a limited scope of practice is recognised as a barrier to early specialisation, it might be a barrier to any specialisation (early or otherwise).

Interestingly, both graduate practitioners interviewed in this research were unconcerned about their limited scope of practice; in fact, they saw this as a benefit rather than a barrier. The competencies required of them appear to match their skill set and they enjoy having focused knowledge in MRI. Their skills are highly sought and they are confident of their future employability. The clinical manager in the USA contradicted this opinion, as she values the flexibility of practitioners who are competent in many areas of practice. This view, however, does not appear to acknowledge that the perceived flexibility of generalist, experiential practitioners may be a fallacy if they become deskilled in other imaging modalities.

Undoubtedly, a major barrier to early specialisation in the UK is registration (see Section 5.3.7.). These concerns are echoed to a certain extent by literature relating to specialist practice in other healthcare professions, where problems associated with accountability, responsibility, competence and regulation are reported (White and McKay, 2004; Stover, 2011). In the USA, graduate practitioners are not excluded from practice solely because they have not first qualified as a radiographer. The only universally applied registration system is the ARRT MRI certification examination. The ARRT offers an examination every two years to anyone who practises MRI. Graduate practitioners are permitted to complete this examination and gain MRI certification to practise. There is no requirement to become certified in radiography first. It is common for graduate practitioners to complete the ARRT examination and gain MRI certification shortly after gaining their qualification (Weening, 2012). Some of the interview responses indicate that

graduate practitioners find it easier to pass this examination, because they have been taught via a formal educational curriculum. Experiential practitioners do not always seek the ARRT certification, especially if their employer or the state in which they work does not require it. Some of the interview responses emphasise the benefits of graduate practitioners being certified and registered to practise on the same footing as their radiographic colleagues. These views are supported by Weening (2012), in whose research leading MRI educators in the USA contest that MRI practitioners must first qualify as a radiographer to practise MRI. Instead, they advocate that MRI job descriptions should universally no longer require pre-existing qualifications in radiography (Weening, 2012).

In the UK, the only imaging professionals who can be registered by the HCPC are graduates from recognised undergraduate radiography programmes. There is no provision to register anyone who enters MRI practice directly. Assistant practitioners in MRI (who are not qualified radiographers but have undertaken a foundation course in MRI) already practise MRI in the UK and may be listed in a voluntary register held by the SCoR if they wish. This, however, does not have the same standing as HCPC registration, and it is evident that this is a significant obstacle to early specialisation in MRI. Although the UK clinical manager interviewed in this study did not perceive this as a problem, because she would employ an unregistered practitioner, this opinion is not necessarily universal. It would be unfair to introduce an undergraduate programme in MRI without a guarantee of employment.

Table 6.2. (p.206) is derived from Table 4.8. (p.132) and links the professional, qualitative research question with a variety of possible outcomes. Although some barriers to early specialisation are recognised, the interview responses identify more benefits of early specialisation than barriers to it. It is difficult to place weight on the barriers but, overall, the benefits seem to be too numerous and important. Therefore, the framework illustrated in Table 6.2. shows that, in general, the qualitative findings of this research support the introduction of an undergraduate degree in MRI (green shading).

**Table 6.2. Professional strand matrix**

Research question	Number of benefits reported in semi-structured interviews	Number of barriers reported in semi-structured interviews	Possible outcome
What are the professional benefits of and barriers to early specialisation in MRI?	High	Low	The professional benefits of early specialisation may justify the introduction of an undergraduate degree in MRI.
	Low	High	The professional barriers to early specialisation may prevent the introduction of an undergraduate degree in MRI.
	Same/similar	Same/similar	The professional impact of early specialisation may justify the introduction of an undergraduate degree in MRI, but further research is needed.

## 6.4. ANALYSIS OF CONNECTIONS ACROSS BOTH STRANDS

The aim of the following section is to explore connections between the quantitative and qualitative strands. The purpose is to address the mixed-methodology research question identified in Chapter 3:

*To what extent do the educational and professional perspectives explored in this study support the introduction of a specialised undergraduate degree programme in MRI?*

As discussed in Sections 6.2. and 6.3., the educational, quantitative and professional, qualitative strands of this study both support the introduction of a specialised undergraduate degree in MRI (see Table 6.1., p.197 and Table 6.2., p.206). Side-by-side comparisons of the key findings of both strands are also made and are shown in Tables 6.3. (p.209) and 6.4. (p.210) (which are based on Table 4.8., p.132). Concordance between the quantitative and qualitative findings is evident in relation to the higher level of knowledge of MRI amongst graduate practitioners (shaded green). There are also some conflicts, which could warrant further expansion (shaded amber).

### 6.4.1. Concordance

There is agreement between the quantitative and qualitative findings regarding the knowledge of graduate and experiential practitioners. There are clear links between the significantly higher OSCE scores of graduate practitioners, with several supportive interview responses. The quantitative findings show that the specialised undergraduate degree in MRI enables graduate practitioners to achieve a higher and more consistent level of residual knowledge than that of experiential practitioners. In every section of the OSCE, the mean scores of the graduate practitioners are higher than those of the experiential practitioners. In addition, the t-test and Cohen's effect size calculation show a highly significant difference between the groups in terms of residual knowledge, with graduate practitioners outperforming experiential practitioners. In general, the qualitative findings concur, with most of the respondents emphasising the value of specialisation in MRI and making clear distinctions between the knowledge and skills of graduate and experiential practitioners. Graduate practitioners are more likely to complete MRI examinations

efficiently and successfully, meaning that patients are less likely to be recalled for repeat examinations.

Strong concordance is found in relation to protocol and image optimisation. There are several references in the qualitative data to graduate practitioners outperforming experiential practitioners in their ability to change parameters. Furthermore, in the quantitative data, the mean score is higher for graduate practitioners in the OSCE section on image optimisation. The interview responses generally concur. Some respondents give examples of experiential practitioners not having enough knowledge to challenge and modify protocol parameters or to recognise and rectify image artefacts. In general, graduate practitioners are considered more knowledgeable and skilled in this subject. This knowledge is also linked by a few of the respondents to several professional benefits, including increased staff retention and higher professional status. For example, having a formal education in MRI may help an individual to gain employment in MRI, especially if they have previously worked in a department as a student. Managers often appreciate the skills of the graduate practitioner and know that the practitioner will fit into the departmental organisation. According to some of the respondents, increased knowledge leads to an improved ability to perform and complete scans and, consequently, to high levels of job satisfaction. In addition, the fact that graduate practitioners are taught via a formal curriculum means that they are more likely to obtain the ARRT MRI certification. In some instances, this enables them to attract higher salaries than experiential practitioners.

**Table 6.3. Quantitative and qualitative connections - concordance**

To what extent do the educational and professional perspectives in this study support the introduction of a specialised undergraduate degree in MRI?	
QUANTITATIVE	QUALITATIVE
CONCORDANCE	
<p>The scores of the graduate group are higher in all five sections of the OSCE and in the OSCE overall.</p> <p>The total OSCE score of the graduate group is higher than that of the experiential group, with a very high level of statistical significance.</p> <p>The graduate practitioners have more consistent levels of knowledge than the experiential practitioners have.</p> <p>The experiential group answer significantly fewer questions correctly and more questions incorrectly in Section 2 (general principles).</p> <p>Graduate practitioners answer a higher percentage of questions correctly in Section 5 (image optimisation) than experiential practitioners did.</p>	<p>'A knowledgeable technologist...sees the abnormalities...gives them extra pictures...call back for the patients is decreased.'</p> <p>'Experiential practitioners make more mistakes...' 'I don't think I have ever recalled a patient from a... (<i>graduate practitioner</i>) but I have from a radiographer.'</p> <p>'People who have been trained on the job...they can't change parameters knowledgeably and that's why they end up with crummy pictures and things take too long.'</p> <p>'(<i>Experiential practitioners</i>) have no idea what they are changing, and that's how...you get really bad pictures.'</p> <p>Employability: '...the standard of education ...is something that I'm sure helped get me the job....' Job satisfaction: '...every day I get to work and just doing MRI, which is what I enjoy...'</p> <p>Professional status: 'I think (<i>of</i>) myself as a highly trained professional that's responsible for...getting the highest quality imaging in order to help them determine what's wrong.'</p> <p>Remuneration: '...bang for buck there's not many bachelor's programmes that you can get right out of the programme without knowing anybody and have the earning capacity that you do in MRI.'</p>



**Table 6.4. Quantitative and qualitative connections - expansion**

To what extent do the educational and professional perspectives in this study support the introduction of a specialised undergraduate degree in MRI?	
QUANTITATIVE	QUALITATIVE
<b>ISSUES REQUIRING EXPANSION</b>	
Questions related to the consequences of altering protocol parameters are poorly answered by both groups.	'She ( <i>a graduate practitioner</i> ) has more a formal educational background in MRI so she understands...how to improve image quality.'
The graduate practitioners achieve a higher mean score in Section 1 than experiential practitioners.	'There are technologists ( <i>experiential practitioners</i> ) out there that don't know what they are doing and that's a scary thought.'
More graduate than experiential practitioners do not volunteer answers for questions related to MRI safety.	'Having an undergraduate programme means that they ( <i>graduate practitioners</i> ) know that you can't go in there with a pacemaker or something like that...'
Graduate and experiential practitioners are equally likely to not answer, or to answer incorrectly, questions related to contraindications to MRI.	

### 6.4.2. Expansion

There is some disagreement between the quantitative and qualitative findings in relation to specific aspects of image optimisation. This is revealed when comparing the opinion of one respondent (who believes that a certain graduate practitioner knows how to improve image quality because she has a formal educational background in MRI) with the quantitative findings, which show that neither graduate nor experiential practitioners score highly on specific OSCE questions about the consequences of altering parameters that optimise image quality (see Table 5.4., p.155 and Section 5.3.2.3.). The discrepancies between the quantitative and qualitative findings are not, however, discordant; according to Table 4.8., discordance would require the graduate OSCE score to be lower than the experiential score in this section. The quantitative findings show that the reverse is true: the OSCE scores are higher in the graduate practitioner group. However, they are not significantly higher, and certain questions are not answered correctly by either group. Presumably, the respondent who makes the comment mentioned

above is reporting on their own experience of one individual. However, this opinion is supported by similar views from other respondents and, overall, the qualitative findings suggest that graduate practitioners are more skilled in image optimisation.

There are also some inconsistencies in the quantitative and qualitative findings relating to MRI safety. The t-test reveals that there is no statistically significant difference between the two groups in Section 1, which includes questions on MRI safety (see Table 5.19.). There is a medium Cohen's effect size, indicating that although the impact of the undergraduate degree in MRI is not as large as it is in the other sections, it still has some effect on residual knowledge (i.e. it is not small). In addition, the chi-square values are above 10 for all answer types (correct, incorrect and DNA) for experiential practitioners in Section 1 (see Table 5.14., p.163). This indicates that, although not statistically different from what would be expected by chance, these data are tending towards not fitting and causes other than chance may be affecting the results. Section 1 also includes questions on anatomy and pathology. When the questions related to MRI safety are isolated, graduate practitioners are more likely to leave these questions unanswered and are equally likely to be unable to volunteer an answer on the contraindications to MRI.

In general, the analysis of the qualitative findings related to MRI safety does not support the quantitative results, with viewpoints suggesting that graduate practitioners have improved knowledge of this subject. Experiential practitioners have more experience in MRI; therefore, they have more practical experience of enforcing MRI safety principles. However, this does not appear to result in increased knowledge of MRI safety. The undergraduate curriculum includes a substantial amount of content on MRI safety, but the opinions of graduate practitioners having more knowledge of this topic are not supported by the quantitative findings. Closer inspection of the interview transcripts shows that MRI safety is mentioned by only two respondents, who make a passing reference to it when discussing patient care. Therefore, the data do not seem to be strongly supportive of the undergraduate degree in MRI having much impact on an individual's knowledge of MRI safety. It is possible that experiential practitioners' exposure to MRI safety issues is balanced by graduate practitioners' increased theoretical knowledge, with neither group out-performing the other. The discrepancies between the quantitative and qualitative findings are not, however, discordant, because the graduate OSCE scores are similar to, rather than higher than, those of the experiential group (see Table 4.8., p.132).

### 6.4.3. Additional professional perspectives

There are some additional professional perspectives that could have an impact on the feasibility of introducing a specialised undergraduate degree in MRI in the UK. However, as they cannot be measured quantitatively via the OSCE scores, it is not possible to make direct connections with the quantitative findings in Table 6.3.

(p.209). The most important of these are the limited scope of practice of practitioners who can work in MRI only, and how and if these individuals (who have not first qualified as radiographers) are registered. Limited scope of practice does not appear to be an obstacle to early specialisation amongst most of the interview respondents, but this might reflect the fact that they work in large departments where staff are available to work in other modalities. Indeed, being able to work in a discrete area of practice considered beneficial by a few of the respondents. Some interview data reflect that being able to focus solely on MRI is one of the principal reasons why practitioners choose to undertake an undergraduate degree in MRI.

There is no reason to believe that the benefits could not be realised if an undergraduate degree in MRI were introduced in the UK, although clearly, some might find practice in MRI too limiting. In small imaging departments, there are likely to be significant problems if practitioners practise in a single modality. The revelation that experiential practitioners may have a similar inflexibility to that of graduate practitioners is important and raises questions about specialist and generalist education and practice. As there are benefits and barriers associated with limited scope of practice, this issue might be neither supportive nor unsupportive of early specialisation. However, it is evident that it is not likely to be possible for MRI practice to be exclusively surrendered to graduate practitioners. It will be necessary to make provisions for flexible staff with transferrable skills, especially in small imaging departments. In addition, the number of cross-sectional imaging departments, where practitioners are expected to work in MRI and CT, is increasing, and it is not clear how these individuals could be catered for.

Registration of MRI practitioners who are not radiographers is not a barrier to early specialisation in the USA. In fact, graduate practitioners in the USA are more likely to achieve ARRT certification in MRI than experiential practitioners. However, registration is clearly a barrier to, and not supportive of, direct entry into MRI practice in the UK. Nevertheless, as the educational benefits of early specialisation

appear to be significant, it seems to be important to find ways to overcome this problem.

The general themes that emerge from the analysis and interpretation of the quantitative, qualitative and merged findings are now explored. The purpose is to widen the discussion to capture more of the educational, professional and political implications of this research.

## 6.5. DISCUSSION

The connections made across the quantitative and qualitative strands of this research lead me to believe that learning MRI through a formal undergraduate programme is beneficial. There is a clear difference in the OSCE scores between graduate and experiential practitioners, indicating that graduate practitioners have more residual knowledge. This is supported by the qualitative findings, which identify substantive professional benefits of employing graduate practitioners. The way in which MRI is learned appears to be impactful, but is there value in learning MRI experientially, and how important is it to be a graduate in radiography or MRI? In the studies relating to specialist and MRI education appraised in Chapter 2, these topics are not identified or discussed by researchers. However, in the light of the findings of my research, it seems to be important to explore what influence experiential and graduate learning might have had on my results.

Educational research often emphasises the benefits of experiential learning (Thompson et al., 2011; Chilton, 2012). It is argued that experiential educational methods allow the learner to discover, process and apply knowledge to their practice. This stimulates deep learning, as it encourages connections between theory and practice (Bethell and Morgan, 2011; Devasagayam, Johns-Mastern and McCollum, 2012) and develops a strong ownership of what is being learned. Dewey's experiential learning model (Dewey, 1938) emphasises that effective experiential learning requires an interaction between the social environment, the way in which learning occurs, the teacher's role and the learner's readiness to learn (Bower, 2014). According to Dewey (1938), the social environment is the relationship between teachers and learners and what is being learned. The interaction between teacher and learner is pivotal, and the role of the teacher is a central theme of successful experiential learning. This makes sense when applied to a formal curriculum that has been designed and delivered by qualified teachers. However, in the context of experiential learning of MRI it is harder to define. Workplace learning in MRI may be *ad hoc* and it is likely that experiential practitioners learn MRI from other experiential practitioners, whose knowledge and teaching skills may be untested (Allen, 2014). The quality and level of learning that takes place for experiential practitioners, therefore, is difficult to quantify. However, as it accounts for most of the learning in MRI, it seems to be important to attempt to do so.

Dewey (1938) identifies knowledge and content organisation as being key components of successful experiential learning. The syllabus, and how it is organised and delivered through the curriculum, is central, because this determines how well students are able to apply theoretical knowledge to practice. Learner readiness allows students to connect their classroom and practical skills through learning activities that prepare them prior to the actual practical experience. For example, students can participate in clinical or laboratory simulations (de Oliveira et al., 2015). In experiential learning of MRI, these important phases of Dewey's model are not in place. MRI is not taught in depth in most undergraduate radiography programmes; therefore, learning MRI experientially post-qualification is not directly connected to recently acquired theory. This may be one reason why experiential practitioners are out-performed by graduate practitioners in my research.

Most of the literature refers to experiential learning in the context of a formal programme of study where knowledge from practice is underpinned by theory. Section 2 of the OSCE, which refers to the general principles that underpin MRI, is the main contributor to the highly significant difference between the total OSCE scores of each group. Therefore, the lack of formal education in this subject amongst experiential practitioners could have been a major influence and may be why the benefits attributed to experiential learning are perhaps not realised in the context of MRI. Graduate practitioners are more likely to have been exposed to curricula that integrate Dewey's experiential learning theory, incorporate the underpinning principles of MRI, and consider how to prepare students for learning in practice. Graduate practitioners, therefore, should be more capable of connecting the knowledge they have acquired in the classroom with their practice during their clinical placement as undergraduates, and they should be able to continue to do this once they have qualified. It is worth noting that in the USA, prospective healthcare undergraduates must have an educational background that includes prerequisite accomplishments in bioscience related subjects. There is research that strongly links this learning with acquired knowledge of science in the undergraduate programme (Caruana and Plasek, 2006). However, as the experiential and graduate practitioners in my research would all have been required to complete prerequisite modules in the biosciences before undertaking their degree in either MRI or radiography, this is unlikely to account for the difference in OSCE scores between the two groups.

Practitioners in both groups are graduates, albeit in different disciplines (radiography and MRI). Therefore, in theory, their graduate skills should not have influenced the findings of my research. Educational research suggests that there is little consensus on the meaning of *graduateness* or what makes someone a graduate. Disciplinary knowledge and an understanding of research are considered important by some, whereas others expect graduates to be professional experts (Steur, Jansen and Hofman, 2012). Several researchers have attempted to explain the characteristics of a graduate regardless of field, but these have resulted in a huge variety of domains (Barrie, 2006). It is evident that in a general context graduateness is hard to define, given the variability of disciplines, HEIs and students. This lack of consensus is confusing for educational policy-makers and academics and limits how graduateness is addressed (Barrie, 2006). HEIs are under pressure to place emphasis on economic indicators, such as employability, rather than intellectual and personal growth (Booth, McLean and Walker, 2009). Consequently, some claim that employability overshadows graduateness and that becoming a graduate is more about professional training than cultivating a strong academic philosophy (Glover, Law and Youngman, 2002). Graduateness is fostered by enabling an individual to develop a reflective attitude through the domains of scholarship, moral citizenship and lifelong learning (Glover, Law and Youngman, 2002). However, the assumption that the graduateness of each participant should not have influenced the findings of this research (because both types of practitioners are graduates) presumes that graduateness is encouraged in the MRI and radiography undergraduate programmes and that graduate skills are not lost post-qualification.

A recurrent theme emerging from the quantitative and qualitative findings is a practitioner's ability to apply theory to practice. Image optimisation is a good example of where it is necessary for a practitioner to connect theory and practice. To select protocol parameters appropriately, it is important to understand the theory behind this process and apply it to different pathologies and patients (Westbrook, 2014). However, the practitioners in this and previous research appear to find this difficult, as evidenced by their OSCE scores. Healthcare professionals need to have a sound knowledge of theoretical principles, but it is important that this propositional knowledge is used effectively. Some believe that knowing how to make use of factual information in the context of practice is more important than the knowledge itself and is best achieved within clinically meaningful situations

(Kaufman, Mann, Jennett, 2000; McLachlan et al., 2004). The essence of gradueness seems to pivot around the idea of transformation (Perry, 1970), not only in terms of expanding knowledge but also in an individual's ability to make the cognitive links between theory and practice (Stevenson, 2003). This transformation happens at a certain stage of intellectual development, and reflective thinking is the key element of this process (Steuer, Jansen and Hofman, 2012). In undergraduate programmes, methods such as clinical preceptorships, case studies and simulations are often used to enable connections between theory and practice, but research suggests that these are not always successful (Kantar and Massouh, 2015).

The inability of an individual to relate propositional or factual knowledge to clinical practice is sometimes called the theory-practice gap (Clark and Holmes, 2007). This gap is apparently most pronounced when a practitioner first graduates and moves from supervised learning to autonomous practice (Whitehead and Holmes, 2011; Monaghan, 2015). Transformation into an autonomous practitioner includes developing confidence through experience, but is also related to the skills acquired as an undergraduate. In the UK, criticism has been levelled at undergraduate nursing programmes because not all nurses are clinically proficient once they have qualified (Ross and Clifford, 2002). This has resulted in the increased implementation of simulation exercises and clinical preceptorships that enable a smoother transition from student to qualified practitioner (Sharples and Elcock, 2011). In radiography, there might be additional reasons for the theory-practice gap: observations suggest that what is taught to students in the classroom is not always what is practised in the clinical setting (Allen, 2014). Research by Allen (2014) surmises that the blame lies not with educational providers, who develop curricula according to published standards, but with the instruction that students are given by qualified radiographers in the clinical setting. It has been suggested that the professional and organisational culture of radiography causes radiographers to perform opportunistically, with no consequences of low-quality performance. A consistent failure to meet practice standards becomes endemic and is passed on to student radiographers during their clinical preceptorships, detrimentally affecting their knowledge and skills (Allen, 2014). This damning research claims that what is taught in the classroom is not what is practised. The inconsistencies require students to learn multiple and sometimes incorrect ways of practising, which are incongruent with theoretical knowledge. Consequently, they find making the



connections between theory and practice difficult, and their success in the educational programme and as qualified practitioners is compromised (Allen, 2014).

The theory-practice gap may be one of the reasons why neither graduate nor experiential practitioners perform well in certain subjects in the OSCE. For example, it might be why practitioners in both groups are unable to identify the consequences of altering parameters in protocols or identify all the contraindications to MRI. It could also be why some cannot identify common anatomical structures or pathologies. A weak transition from supervised learning to autonomous practice might account for the theory-practice gap amongst some of the graduate practitioners who graduated quite recently, but it does not account for those who have been qualified for many years. Practitioners in the experiential group are different in that they have little underpinning theory to support their practice and there may be few opportunities for them to bridge the gap between theory and practice in the workplace. Both types of practitioner may have also been influenced by the forces reported by Allen (2014). If so, solutions are harder to find. From an educational standpoint, incorporating educators as clinical facilitators or encouraging practice that is more reflective amongst MRI and radiography students might be helpful. However, large-scale profession-driven solutions designed to change organisational and professional culture could be necessary. It is worth noting that the lack of practice skills reported by Allen (2014) may be one of the reasons why experiential learning of MRI does not appear to develop residual knowledge. If experiential practitioners are learning from other experiential practitioners who do not have high levels of residual knowledge themselves and are not able to connect theory with practice, this lack of skill is cascaded, resulting in the perpetuation of poor practice (Allen, 2014).

My research suggests that being a graduate in MRI rather than in radiography results in higher levels of residual knowledge, as evidenced by the significantly different OSCE scores. This is especially noticeable regarding the general principles that underpin MRI, as this section of the OSCE produces the most significant difference in OSCE scores (and, therefore, the most significant difference in residual knowledge) between the groups. How, then, should curricula be designed so that they capture the necessary content and are congruent with UK educational and professional standards? The American and Canadian models provide a useful starting point. Appendix 8 shows the recommended MRI undergraduate curriculum developed by the American Society of Radiologic

Technologists, American Educators in Radiologic Sciences and the International Society of Magnetic Resonance in Medicine. This comprehensive curriculum is designed to capture the theoretical and clinical requirements of an entry-level MRI practitioner and includes modules of study on anatomy, pathology, MRI safety and protocols in a range of MRI examinations. The curriculum is also designed to integrate the ARRT competency standards and the content specification for the ARRT MRI certification examination (ARRT, 2014). Currently, 37 HEIs in the USA offer either an associate or a bachelor's degree in MRI (Weening, 2012) and most (but not all) use this combined curriculum. The associate degree usually involves two years of study, with an additional research year for the bachelor's degree. The American MRI undergraduate curriculum is largely mimicked by the Canadian Association of Medical Radiation Technologists' magnetic-resonance competency profiles, which are provided as a guide for the curricula of accredited MRI programmes (Canadian Association of Medical Radiation Technologists, 2014). Although they make no specific reference to the level of award conferred by these programmes, the language used is similar to the QAA level six descriptors for a BSc award (QAA, 2014).

Very little research exists on the effectiveness of these curricula in terms of improving knowledge and how knowledge is applied to practice. Weening, Gilman and Greenidge (2012) use retrospective data to ascertain that those who have undertaken an undergraduate programme in MRI are more likely to pass the ARRT MRI certification examination. This implies that these programmes are beneficial, but, to the best of my knowledge, there is no published literature that directly compares the outcomes of different curricula offered at different degree levels by different HEIs in either the USA or Canada. Some of the findings of my research suggest that the undergraduate curriculum has not been impactful in some topics, such as anatomy and pathology, MRI safety and image optimisation. Examples are found where graduate and experiential practitioners demonstrate a lack of knowledge in these subjects. This raises questions about how these fundamental principles are taught and the best way of integrating them into the curriculum. Are entirely specialised programmes, where there is no mixing of core and generic subjects, the best way forward, or should these be combined?

A solution might be to teach specialisations, such as MRI, alongside other imaging modalities. For example, the first year of the curriculum could include generic foundation subjects, such as professional practice, patient management and

behavioural sciences. Students could then split into different specialisms for the next two or three years of the programme. However, it would be necessary to clearly define and discriminate between foundation and specialist knowledge and think carefully about how general theories are applied to each specialism. For example, although many patient-management considerations apply to all modalities, some are specific to MRI, such as claustrophobia. When would this be taught in the curriculum? Another question is how specialist awards would be conveyed. As the HCPC currently only registers graduates of an approved BSc radiography programme, a practitioner with a BSc in MRI cannot be registered to practise. However, it is unlikely that an HEI would be able to validate a named award in radiography if the focus of the curriculum is MRI. The situation is complicated even further if graduates are permitted to learn more than one specialism. It is not uncommon for practitioners to work in MRI and CT; therefore, programmes that allow students to gain qualifications in both modalities might be popular. This option would overcome some of the barriers to early specialisation in one discrete area of practice, as practitioners would be able to work more flexibly. However, from an educational perspective, it could be problematic in terms of credits, the time frame for study and how the award is named.

Another anticipated problem is how to determine the most appropriate type of award. The level descriptors used in the UK do not easily align with those used in the USA (Steuer, Jansen and Hofman, 2012). For example, it might be difficult to map the content and assessment of an associate-level award in the USA with an equivalent in the UK. Starting with a standardised bachelor-level degree programme in MRI might provide a better fit with the equivalent award in radiography. This is an important consideration for HEIs in the UK that wish to offer programmes in both subjects, as some elements are likely to be shared by both programmes. Furthermore, if individuals who already have a bachelor's degree in radiography wish to undertake an additional award in MRI, how would their educational qualification be classified?

There are also professional concerns attached to having different educational levels in the same subject. If HEIs in the UK were to introduce associate degree awards in MRI, there might be consequences in terms of how these graduates integrate with their bachelor-degree colleagues in the workplace. Does this open up the possibility of hierarchical conflicts and the fragmentation of the imaging profession? Awards at different educational levels might prove to be too complex and divisive in practice. It

is important to note, however, that these issues do not appear to have been realised amongst the participants in this study. The qualitative findings of my research imply that graduate and experiential practitioners work seamlessly alongside each other, and the type of degree attained is not raised by any of the interview respondents.

A final consideration is how a specialised undergraduate degree in MRI could be paid for. In England, radiography education is currently funded by the Department of Health and Health Education England (HEE) via an NHS bursary. However, from August 2017 every radiography student will be required to take out a loan to cover their tuition fees, which may well fall short of the funding required by HEIs to deliver a full radiography programme (Nightingale, 2016). This, and the fact that the government has pledged an additional 10,000 nursing, midwifery and allied health university training places by 2020, is likely to put severe pressure on HEIs. Some may have to look at radically new ways of delivering radiography education, including single-modality curricula (Nightingale, 2016). However, the combination of financial restrictions and a requirement to provide more training places might benefit students embarking on a specialised degree in MRI, especially if a narrower curriculum permits a shorter and more cost-effective educational delivery model. The availability of clinical placements is also an important consideration. Traditional radiography programmes can be difficult to manage, as students must be placed in a variety of clinical settings to gain exposure to a range of imaging modalities. In theory, it should be easier and less costly to find clinical placements for students on a single-modality undergraduate programme.

The themes that emerge from this discussion reveal the complexity of this problem. Issues surrounding course content, delivery, funding and registration are evident. However, as my research suggests that direct entry into MRI practice via a specialised degree is beneficial, it seems to be important to find solutions.

## 6.6. VALIDITY, REPRODUCIBILITY AND GENERALISABILITY

The potential limitations of the design of this study are explained in detail in Sections 4.2. to 4.6. The following discourse is a further reflection on the validity, reproducibility and generalisability (or transferability) of the findings.

### 6.6.1. Quantitative findings

Given the time and cost limitations of collecting the data myself in the USA, I am pleased with the number of participants included in the quantitative strand of this research. The sample size broadly reflects the recommendations for comparative studies (Salkind, 2014). The highly statistically significant result of this research, make the claims I make meaningful. Even if the sample size had been substantially larger, the remaining participants would have had to perform very badly in the OSCE to overturn the significant difference in scores.

The OSCE was chosen as the quantitative measurement instrument because it is a well-recognised and objective assessment method (Habeshaw, Gibbs and Habeshaw, 1993; Forward and Hayward, 2005). The objectivity of this method should mean that the findings of the quantitative strand of this study are reproducible. Other researchers using the same OSCE questions to test the same knowledge in individuals with the same defined characteristics should achieve similar results to those of this study. I am confident that the participants are representative and that there is no reason to believe that their OSCE scores are any different from those of other graduate and experiential practitioners, had they been tested. The fact that the quantitative findings are corroborated by previous research is also encouraging. With the exception of Section 4, all of the OSCE questions used in this research are identical to those used in previous research (Westbrook and Talbot, 2009) and there is correlation between some of the findings. In addition, researchers in two European countries have subsequently used the same OSCE questions to assess experiential practitioners and have achieved similar results (work in progress).

It is important to consider whether the outliers (i.e. individuals who attained very low or very high OSCE scores) might have skewed the results. For example, the lowest total OSCE score in the experiential group is 18% and the highest is 87%. In the

graduate group, these scores are 47% and 85%, respectively. It is possible that these individuals could account for the statistically significant result. However, further analysis reveals that if these data are removed, the difference in total OSCE scores remains highly statistically significant. It is also noted that although the chi-square tests all show that the results could have been caused by chance, in some sections of the OSCE the data are tending not to fit. For example, in the graduate group the chi-square value is higher for incorrect answers in Section 4 and for correct and DNA in Section 5. It is important, therefore, to consider whether the lowest-scoring individual in the graduate group accounts for this. However, the lowest-scoring graduate practitioner did not answer a minimal number of questions in all five sections, and the highest graduate scorer did not achieve an especially high score in Section 5. In the experiential group, the chi-square values are higher for all types of questions (correct, incorrect and DNA) in Section 1, for correct and incorrect in Section 4 and for DNA in Section 5. However, the lowest-scoring individual in the experiential group performed badly in all five sections of the OSCE, and the highest experiential scorer achieved high scores in all five sections. In fact, the highest score in all the data was achieved by this individual in Section 3, which is a section where the chi-square value approaches zero. Therefore, the outliers do not seem to account for the tendency of the data not to fit in some sections of the OSCE.

In Section 4.2.5., co-variables that could influence the quantitative findings are identified. These include how long ago MRI was studied by practitioners in each group, practitioners' relative experience in MRI, their learning styles, and whether they had been previously assessed in MRI. These are important considerations, as they may have more impact on the OSCE scores than how each participant learned MRI. To ensure that I examine these co-variables as transparently as possible, I return to the quantitative research question and ask it in a slightly different way: how can I account for the differences in residual knowledge of MRI between the two groups?

Firstly, it is possible that the difference in OSCE scores is biased by the fact that the graduate practitioners have learned MRI more recently than some of the experiential practitioners, who may have learned MRI some time ago. This is a very difficult variable to pin down. When does learning begin? Does learning have a definite end-point? Graduate practitioners can correlate their learning with the period of their undergraduate programme, but does learning begin on the first day

of the course or on the day when they graduate? Experiential practitioners may find it even harder to define when learning took place. In addition, both types of practitioner learn MRI experientially to some degree. For experiential practitioners, this is the only way in which they learn MRI, but graduate practitioners also learn experientially during their studies and after they graduate. Therefore, it is not possible to entirely isolate non-experiential learning amongst the graduate practitioner group. What is certain is that the experiential group had not been exposed to any formally taught undergraduate programme. Therefore, this co-variate is acknowledged, but it is very difficult to define and collect meaningful data about it.

The quantitative findings may also be influenced by the experience that a practitioner has in MRI. Data were collected on this co-variate, with experiential practitioners having nearly twice as much experience as graduate practitioners. It might be expected that maximal experience results in higher OSCE scores, because time in practice might be an indicator of opportunities to learn. However, the quantitative findings show that this is not the case. Experiential practitioners have consistently lower OSCE scores, even in areas where one might expect experience to be important (MRI safety and image optimisation, for example). The lower OSCE scores in the experiential practitioner group suggest that knowledge is not related to experience alone. The experience of experiential practitioners does not seem to have been as influential on these results as the way in which they learned MRI. This is supported by research in other healthcare professions. For example, a study that explored nurses' ability to relate their knowledge of bioscience to practice found that the number of years in practice is not an indicator of the amount of learning and knowledge (McVicar, Clancy and Mayes, 2010). The study surmises that the amount of knowledge and learning is more likely to be related to the capacity of an individual to take advantage of opportunities to question and follow up what they have observed than to their level of experience.

It is also possible that each participant's learning style influenced their OSCE score. Learning styles are the characteristic ways in which information is processed and how learning situations are experienced (Sadler-Smith, 1997). Different adults have different preferences for methods, environments and structures of learning. It is possible that performance in the OSCE was influenced by each individual's ability to learn, retain and apply knowledge. The higher OSCE scores in the graduate practitioner group could be caused by their learning styles being best suited to the

teaching methods used in the undergraduate programme. Conversely, the poorer scores in the experiential group could be caused by a misalignment of their learning styles and experiential learning methods. However, as the way in which people learn is so diverse, it is very unlikely that all graduate and all experiential practitioner learning styles were aligned in this way. If learning styles were influential, I would expect very little difference in the OSCE scores between the two groups, because there would have been practitioners in both groups whose learning style was either aligned or misaligned with the learning method used. The highly statistically significant difference in the OSCE scores suggests that the cause is much more clear cut. Therefore, it is unlikely that learning styles had more influence on the OSCE scores than the educational method itself.

The final co-variate – whether participants' knowledge of MRI has been previously assessed – may have an impact on the quantitative findings. Currently, the best assessment benchmark is the ARRT MRI certification examination, because this is the only form of standardised assessment available to both groups in the USA. It is highly likely that all the graduate participants in this study have successfully completed the ARRT examination, because most HEIs design their curricula in line with the ARRT requirements. Some also market their undergraduate programmes by claiming that they enable graduates to pass this examination and become registered practitioners. There is evidence to suggest that practitioners who have completed an undergraduate programme are more likely to pass the ARRT MRI certification examination (Weening, Gilman and Greenidge, 2012). The experiential practitioners are less likely to have undertaken this examination, and this might have had more impact on their OSCE scores than the way in which they learned MRI.

Assessments are a well-known motivator for learning. Individuals tend to adopt an approach to learning according to whether they perceive the task as superficially important and requiring only memorisation, or as a deep task that requires meaning to be made (Dunn et al., 2004). Learners are influenced by several factors, including prior learning and quality of teaching, but assessment is deemed the most important (Ramsden, 1992). To understand the influence of this co-variate, it would be necessary to include data on whether each participant had successfully completed the ARRT MRI certification examination and explore any correlation with their OSCE score. During the design phase of this research, I considered what data other than the OSCE score would be valuable. Completion of the ARRT



examination was discounted to limit my research to clearly defined boundaries. The overarching research question refers to exploring the best way of educating MRI practitioners, and I did not feel that collecting data on whether practitioners had been assessed previously was appropriate. However, clearly this is an area for further research. To summarise, although co-variables are acknowledged, with the possible exception of previous assessment their influence on the results is thought to be minimal. The way in which MRI is learned appears to be the factor that is most likely to influence the OSCE scores, and, therefore, residual knowledge.

### 6.6.2. Qualitative findings

It might have been prudent to interview more stakeholders, particularly in the UK, to gain a wider perspective on the professional aspects of early specialisation. The number of stakeholders was limited to eight in an attempt to constrain the amount of data. As a mixed methodological approach was chosen, there was a large amount of quantitative and qualitative data to process. It was important to try to balance the need to elicit as broad a range of views as possible with the need for a manageable amount of data. However, it is evident that to fully explore the feasibility of introducing a specialised undergraduate degree in the UK, further qualitative research is needed. This includes widening the interviews to capture a range of different views on this issue.

I chose semi-structured interviews as the qualitative measurement instrument, as I wanted to capture the perspectives of individuals who either have a lived experience of graduate practice or are in a position to influence policy. Qualitative data-collection methods, however, are highly subjective and potentially open to bias. Therefore, they are not reproducible or transferable, but they enabled me to collect rich data about the professional benefits of and barriers to early specialisation (Silverman, 2006). I constructed a framework of interview questions from themes identified from the literature. Ferris (2009) and White and McKay (2004) are especially useful in this regard, and I am confident that the wording and sequencing of the questions enabled a thorough exploration of the professional benefits of and barriers to early specialisation with each participant.

The interviews were, I believe, conducted successfully. Each interview began with a question about specialisation and how it is defined, but many participants found this

difficult to answer. I included it in the interview framework to explore whether specialisation is considered an advancement of, or difference in, practice. This theme is important, because it could be influential in determining at what level MRI should be taught. Most of the participants went off on a tangent and provided answers related to the education of specialists, rather than offering opinions on how specialism is best defined. Specifically, graduate practitioners found this question difficult. This may be because they work in a discrete area of practice and, therefore, they possess a rather narrow perspective on specialisation. It is not clear why this question was problematic to the other respondents. It is perhaps too abstract for an early interview question. Nonetheless, the answers provide a useful insight into each participant's views on specialist education, which proved to be important when the findings were connected in the interpretation phase of this study.

Other interview questions were modified depending on the role of each participant. Graduate and experiential practitioners were asked different questions from those that the clinical managers and the academic and UK professional body participants were asked, because it was necessary to elicit different information. This could have resulted in very disparate views but, the responses were quite similar. For example, with the exception of the UK professional body representative, all participants provided accounts that are mostly supportive of early specialisation in MRI. This consensus is unexpected, as I purposefully selected participants for interview to extract a range of opinions and perspectives. I had anticipated that the responses of some participants could reflect their own experiences of early specialisation in MRI, but that others might choose a more holistic perspective. For example, the views expressed by an individual about their direct experience of working with graduate practitioners might be influenced by whether they have had a particularly good or bad experience. In practice, I do not believe that this occurred, although clearly some of the participants have existing agendas. For example, the clinical manager in the USA consistently compared the standards of undergraduate MRI students with those of the qualified radiographers in her department, resulting in claims that these students have poorer patient-handling skills. This is clearly an unfair comparison, as the knowledge and skills of undergraduate students are not likely to be better than those of qualified staff.

I also recognise the possibility that some participants could have provided answers that they thought I wanted to hear rather than giving their own opinions. This is an

acknowledged difficulty with interviews (Allen, 2004) and I attempted to combat it by carefully avoiding leading or closed questions and making sure that I remained as neutral as possible. It was sometimes difficult to ask an open-ended question when trying to clarify interview responses or further explore certain themes. However, overall, I am confident that the accounts given by all of the participants are genuine and true representations of their views on the qualitative themes of this research.

NVivo was used to code key words and phrases in the interview transcripts and to find patterns and links between them. Although I recognise that it is possible to impose my own meaning when coding, I did try to step back from the data and view it as objectively as possible. In an attempt to limit the possibility of misinterpreting or misrepresenting the views of each respondent, I chose extracts from the interview transcripts that appeared to be clear and unambiguous. However, did I use a sufficient level of abstraction during the coding process? Saldana (2009) puts forward a strategy called the 'touch test', which allows progression from the real to the abstract when coding qualitative data. To differentiate between topics and concepts, he uses examples, such as being able to physically touch a mother but not the concept of motherhood. I mainly used descriptive coding during the data analysis, as I felt that this was most suited to addressing the professional, qualitative research question. My analysis focused on common and contrasting emergent topics and finding any links between them, rather than seeking out abstract concepts. I do not believe, however, that the analysis required an abstract level of interpretation. The purpose of the professional strand of this study was to explore participants' opinions about early specialisation that were based on their experiences (as opposed to their feelings). Throughout the process, I consistently applied an iterative approach, in that I continuously re-visited the data to ensure they supported the findings. I am confident, therefore, that the analysis of the qualitative data was successful overall and that the findings of this strand of the study are truthful.

### 6.6.3. Connected findings

The sample sizes in both strands of this study are relatively small. However, one of the advantages of using a mixed methodology is that it enables the researcher to make connections between the data: these connections are more powerful than each type of data on its own (Tashakkori and Teddlie, 2010). Therefore, the traditional weaknesses of one method of data collection are outweighed by the presence of other types of data and the links made between them (Tashakkori and Teddlie, 2010). Consequently, I am convinced that the concordant connections I have made between the two strands of the study are more influential than either the quantitative or the qualitative findings on their own.

After honest and rigorous analysis of the research process, I am confident that I have adhered to the spirit of mixed-methodology design. Multiple research questions reflect the quantitative, qualitative and mixed-methodology aspects of this research problem. As shown in Chapter 3, these align with appropriate methods of data collection. The theoretical and philosophical perspectives are congruent with a mixed-methodology approach, and the type of design I have chosen reflects the need to use both types of data to get a full picture of the research problem. Validity checks were performed on the data collection and analysis in both strands of this study. Both types of data were independently analysed and the findings were connected in keeping with a convergent nested design, where comparisons between the findings are meaningful.

According to Creswell and Plano Clark (2011), when looking across findings in a concurrent nested design, potential validity threats include using inadequate approaches to connect the data and making illogical comparisons between the two results of analysis. To limit this, I purposively chose to follow the authors' recommendations and developed a joint display that provides a side-by-side comparison of the key statistical results, matching these where possible with quotes from the qualitative data. One of the challenges I encountered was how to interpret and draw conclusions from the qualitative findings. In Table 4.8., (p.132) I identified three possible outcomes from analysis of the qualitative data; that either professional benefits outweigh the barriers, or that barriers outweigh benefits, or that they are equal. This strategy was used to try and make a clear and unambiguous decision about how to connect the qualitative and quantitative

findings. However, this does not account for the relative importance I might place on each benefit or barrier. For example, registration is a significant barrier to early specialisation of MRI practitioners in the UK. Therefore, although the number of benefits I have identified exceeds the number of barriers, the impact of registration might be substantial enough to outweigh these benefits. It is important to note, however, that the quantitative, educational strand of this study is dominant because it relates to the knowledge of safe and competent practice. Therefore, as these data show that graduate practitioners in this study have a higher level of residual knowledge than the experiential practitioners, and there is concordance between both types of data, I suggest that any barriers, no matter how significant they might be, should be overcome in favour of a new educational policy.

I am satisfied that I have identified and addressed any tensions between the two paradigms and that I have been transparent about any inconsistencies. I believe that conflicts are reconciled, but I acknowledge that as a new mixed methodologist it is possible that I have overlooked some connections. However, I am convinced that the main concordances between the data have been found and explained, and that areas requiring further expansion have been broadly identified. Therefore, I am confident that appropriate and defensible conclusions can be drawn from the combined data.

## 6.7. CONCLUSION

Despite its limitations, this research has several important strengths. It uses a type of mixed-methodology design that is congruent with the need to explore the feasibility of introducing a specialised undergraduate degree in MRI as a means of finding the best way to educate MRI practitioners. The three research questions, identified and justified in Chapter 3, clearly articulate the need to address the educational and professional aspects of this problem and the need to incorporate a mixed-methodology question so that connections between both types of data can be made. The quantitative results are based on a very objective assessment method using well-tested questions from previous research. The OSCE participants, whose characteristics are clearly defined and make clear distinctions between how MRI was learned, reflect a range of clinical settings across four states in the USA. The quantitative results are significant and are supported in several places by the qualitative findings, which are based on a traditional qualitative method. The interview questions were developed from previous qualitative research into specialisation in radiography, and the interview participants were chosen to reflect as wide a range of anticipated opinions as possible.

In the next and final chapter, I summarise the factual, interpretive and conceptual conclusions of this research and use the fitness framework identified in Chapter 1 to draw the themes of my research together. I also reflect upon my journey as a researcher and make recommendations for further research.

# CHAPTER 7: CONCLUSION

## 7.1. PURPOSE AND ORIGINS OF THIS RESEARCH

This research set out to explore how best to educate MRI practitioners by specifically investigating the value of direct entry into MRI practice via a specialised undergraduate degree. This approach is a relatively recent addition to the myriad of different ways in which practitioners learn MRI and, so far, it has been adopted only in the USA and Canada. The research problem identified in Chapter 1 is that there is no standardisation of educational provision in MRI. Traditionally, practitioners are qualified radiographers who then go on to learn MRI experientially or through postgraduate programmes. However, previous research highlights a lack of knowledge amongst MRI practitioners and possible flaws in these systems (Westbrook and Talbot, 2009; Weening, Gilman and Greenidge, 2012). The proposition made at the beginning of this research is that this lack of knowledge is caused by experiential learning being too *ad hoc* to be effective, and that postgraduate learning does not correctly align with the knowledge and skills required of an MRI practitioner who first enters practice.

The literature reviewed in Chapter 2 reveals that specialisation is hard to define but is consistently seen as the development of expertise post-qualification (White and McKay, 2004; Ferris, 2009). Therefore, specialisation is commonly considered to represent an advancement of previously acquired knowledge. However, my research challenges this idea and contests that, because MRI is not taught in much depth in most undergraduate radiography programmes, learning MRI post-qualification cannot necessarily be considered as advancing knowledge. The basic proposition is that knowledge and practice in MRI is unusual rather than unusually superior, and this is why existing educational models might be failing (Westbrook and Talbot, 2009; Castillo et al., 2016).

My research seeks to discover whether learning MRI via a specialised undergraduate degree improves the acquisition of knowledge and, therefore, is a better way of educating entry-level MRI practitioners. This is based on the ideas that formal programmes overcome the problems associated with experiential learning by standardising educational provision, and that undergraduate curricula align with the skills and competencies required of an entry-level practitioner more correctly than postgraduate study does (QAA, 2014). The latter rationale is grounded in the well-described theoretical constructs of Bloom and Benner, which



map increasing knowledge, skills and cognition with the first three years of an undergraduate programme (Bloom et al., 1956; Benner, 2004). These also align with the expected skills and competencies of entry-level practice as defined by the Skills for Health national occupational standards in MRI (2008) and the SCoR (2013b).

## 7.2. SCOPE AND DESIGN OF THE RESEARCH

The themes identified in Chapter 2 revealed that there are educational and professional aspects of early specialisation; therefore, my research design needed to capture both. Consequently, a mixed-methodology approach was adopted and grounded in the congruent epistemological perspective of pragmatism. I do not want my research to be a merely esoteric intellectual exercise but to have a practical impact on MRI education. The primary research question – how do we best educate MRI practitioners? – is a real-world problem that requires an authentic, credible approach. It was evident that quantitative and qualitative data were both needed to fully scope the research problem. A quantitative component focused on the educational perspectives of early specialisation in MRI via an undergraduate degree. This was supported by a qualitative strand, which addressed the professional impact of such an intervention. Both strands were included in a convergent nested mixed-methodology design in which the quantitative element was dominant. The findings from each strand were connected during the analysis and interpretive phase of the study. The aim was to discover to what extent both elements support the introduction of an undergraduate degree in MRI in the UK.

An OSCE was used to assess the knowledge of a group of MRI practitioners. The OSCE questions tested knowledge in five subjects pertinent to MRI practice and had previously been utilised in research testing similar knowledge. Two groups of MRI practitioners who have learned MRI in different ways were identified so that a clear comparison could be made between them. The professional aspects of early specialisation were also explored via semi-structured interviews. A range of different stakeholders were selected to assess different perspectives on early specialisation. The quantitative data were analysed using established statistical analytical tools, and the themes that emerged from the qualitative data were coded using a well-tested instrument. Both types of data were analysed separately and links were made between the findings using a connections matrix. Examples of concordance and inconsistencies that might warrant expansion were explored.

The following conclusions relate to what is described within certain boundaries of my research. Firstly, I deliberately compared undergraduate with experiential learning methods. Other educational models, such as postgraduate study, were

excluded. Undergraduate learning was chosen because this is the educational method under scrutiny. Experiential methods were selected because they are the most common way of learning MRI and, therefore, this is the most useful comparator. Other models, although considered worthy of investigation, were omitted to limit this research to what is possible and optimise its usefulness in practice. Secondly, the OSCE was designed to test working knowledge as applied to practice (defined as residual knowledge) rather than knowledge recently acquired or memorised. I made this choice to ensure that the measurement instrument assessed the knowledge that a practitioner is likely to apply in practice.

Thirdly, the proposition and conclusions I made about the best way to educate MRI practitioners relate specifically to entry-level practice. The skills and competencies I refer to throughout this research are mainly associated with practitioners who either first enter MRI practice or practise MRI at a basic level. I acknowledge that practitioners who have leadership or other advanced practice roles need different skills and competencies; thus, they are likely to benefit from different types of education from those included in this research. Finally, discussions that relate to the feasibility of introducing a specialised undergraduate degree are restricted to practice in the UK. These constraints were put in place to ensure that my research has specific relevance to this country. Although I believe that the findings are transferable, I recognise that the practice and education of MRI practitioners is diverse and the educational model that my research explored might not be globally relevant. I also acknowledge that by primarily collecting data in the USA the conclusions I draw refer specifically to American practice. Nonetheless, I am confident that these results are authentic and the conclusions I make could realistically apply in the UK.

### 7.3. FACTUAL, INTERPRETIVE AND CONCEPTUAL CONCLUSIONS

The key conclusions drawn from this research are summarised in Table 7.1. (p.241) and are divided into primary and secondary findings. My research intends to answer three research questions, which are identified in Chapter 1 and are explained and justified in Chapter 3. Factual and interpretive conclusions are mainly drawn from the findings that address the first two questions. These refer to educational, quantitative and professional, qualitative aspects of the research problem. Conceptual conclusions are mainly drawn from the third, mixed-methodology question, which is designed to extract the collective themes and links between the findings of both strands of the study.

The educational, quantitative research question is: *What is the relationship between the educational level at which a practitioner learns MRI and their residual knowledge of MRI theory?* My research finds that practitioners in this study who learned MRI only via an undergraduate degree in MRI achieved higher mean scores in all five sections of the OSCE (and, therefore, in the OSCE overall) than those who learned MRI experientially. The experiential practitioners in this study answered more questions incorrectly and left questions unanswered more frequently than graduate practitioners. The range, standard deviation and variance of their OSCE scores were also greater, demonstrating a difference in the consistency of knowledge between the two groups. Inferential statistical analysis is strongly corroborative. The two-tailed t-test reveals a highly significant difference in OSCE scores between the groups, which is supported by Cohen's effect size calculations. Sections 2, 3 and 4 of the OSCE are responsible for the significant difference in OSCE scores. Section 2, which tests respondents' knowledge of the general principles of MRI, mainly accounts for this result.

I am confident that the quantitative findings successfully address the educational research question. My research has found that amongst the participants in this study a relationship exists between how MRI is learned and residual knowledge. Graduate practitioners have more residual knowledge of MRI than experiential practitioners, as evidenced by their OSCE scores. The variables are acknowledged and explored in Chapters 4 and 6, but the highly significant difference in OSCE scores (and, therefore, residual knowledge) indicates that this is more likely to be

caused by differences in the way in which MRI is learned than by any of the co-variates or chance alone.

There are, however, some subjects in the OSCE in which low scores are achieved by practitioners in both groups. Sections 4 and 5, which relate to image production and image optimisation, are not answered as well as the earlier sections by either group, and several questions are particularly poorly answered by some graduate and experiential practitioners. These refer to the contraindications to MRI and the consequences of changing parameters within a protocol on image quality and scan acquisition. These data are interpreted to mean that neither educational model may prepare MRI practitioners in certain subjects and that this might be due to the theory-practice gap.

In Chapter 3, I align the three lower levels of Bloom with the equivalent levels of Benner, both of which are commonly mapped to the first three years of an undergraduate programme (Figure 3.3., p.73). By doing so, I connect the increasingly complex cognitive behaviours of Bloom's stages 1 to 3 (knowledge, comprehension and application) with Benner's skills-acquisition hierarchy (novice, advanced beginner and competent). The idea behind these connections is to show that undergraduate-level curricula are designed to enable competent practice. Competent practice in turn, aligns with the knowledge and skills required of an entry-level MRI practitioner (see Table 1.1., p.11). The quantitative findings of my research show that these assumptions may be well founded, because the graduate practitioners in this study, who have learned MRI via an undergraduate curriculum, have high levels of residual knowledge in most topics. It is worth noting that the distinctions made in Table 1.1. are between undergraduate and postgraduate education, whereas in this research undergraduate and experiential learning are compared. However, the highly significant difference in OSCE scores between graduate and experiential practitioners implies that undergraduate programmes may meaningfully affect residual knowledge and have an impact on how MRI is learned.

The professional, qualitative research question is: *What are the professional benefits of, and barriers to, early specialisation in MRI?* My research finds that, based on the opinion and experience of most of the interview respondents in this study, graduate practitioners have higher levels of knowledge than their experiential practitioner colleagues, and this has several benefits. These benefits include

improved patient experience (because scans are performed more efficiently and comprehensively) and fewer patient recalls for repeat examinations. By contrast, three of the eight interview responses identify concerns over the lack of knowledge of experiential practitioners and claim that this affects their ability to practice safely. Departmental cost-benefits are attributed to learning MRI via an undergraduate degree, because the knowledge of graduate practitioners seems to improve patient throughput and reduce training costs and scanner downtime.

Another benefit that this research identifies is the perceived ability of graduate practitioners to change and modify scan protocols. Graduate practitioners appear to consistently out-perform experiential practitioners in this area of practice. In addition, the interview responses give the impression that having the knowledge and skills to perform well improves the professional status of graduate practitioners and, therefore, increases their enjoyment of their job. It also leads to higher remuneration in some cases. Finally, according to some of the respondents in this study, graduate practitioners fit well into the departmental organisation and there is no reported resistance or professional jealousy.

These benefits, however, are balanced by some significant barriers. Restricted practice limits the employability of graduate practitioners and there are some consequent practical implications, including the inability of a graduate practitioner to undertake MRI screening techniques that use X-rays. Registration obstacles are highlighted by the UK participants; however, these are not perceived to be barriers to early specialisation in the USA, because graduate practitioners are permitted to register to practise MRI.

The interpretation of the qualitative findings successfully addresses the professional research question. It is possible to explore the benefits of, and barriers to, early specialisation through semi-structured interviews with key stakeholders. Although significant barriers are identified, there are also several benefits of employing practitioners with a high level of knowledge. According to many of the respondents in this study, graduate practitioners have a better understanding of the underpinning theory; therefore, they may be more competent in key areas of practice. Limited scope of practice, although recognised, is not realised amongst most of the participants in this study. The most significant barrier to early specialisation in the UK is registration, and this is likely to impact on the feasibility of introducing direct entry into MRI in this country.

The mixed-methodology research question is: *To what extent do the educational and professional perspectives explored in this study support the introduction of a specialised undergraduate degree programme in MRI?* The connections between the findings of both strands of this study lead me to conclude that the educational and professional perspectives explored via the first two research questions generally support the introduction of a specialised undergraduate degree in MRI in the UK. The quantitative findings of this study dependably show that the specialised undergraduate degree in MRI enables graduate practitioners to achieve a higher and more consistent level of residual knowledge than experiential practitioners. In general, the qualitative findings concur, with most of the respondents in this research emphasising the value of specialisation in MRI and making clear distinctions between the knowledge and skills of graduate and experiential practitioners. There are a few examples of inconsistencies between the quantitative and qualitative findings. For example, the quantitative data suggest that graduate and experiential practitioners in this study score poorly in the subject of MRI safety and in certain aspects of image optimisation. However, the qualitative data point to graduate practitioners being more knowledgeable in these subjects. These conflicts do not oppose early specialisation; rather, they highlight examples of where the undergraduate programme might be improved.

A mixed-methodology design with a more dominant educational strand was chosen in recognition of the importance I place on the educational aspects of early specialisation. My research finds that learning MRI via an undergraduate degree significantly improves knowledge and that this has several benefits for patients, employers and practitioners. Although patients' views are not included in this study, the benefits of being scanned by knowledgeable practitioners are implied. Consequently, I suggest that obstacles, such as how to register direct-entry practitioners in the UK, need further investigation and solutions need to be found. Finally, my research supports the findings of previous studies identified in Chapter 2, which strengthens my conclusions. The significantly higher levels of residual knowledge amongst the participants in this study who have completed a specialised undergraduate programme, supported by viewpoints that reflect improved scan efficiency, patient safety, job satisfaction and staff retention, indicate that specialism is beneficial. These findings are similar to those in the literature that values specialisation and makes clear distinctions between the benefits of specialisation and the drawbacks of general practice. However, it is also evident that general

imaging practice is important. There are well-recognised benefits associated with having a broader perspective than specialist practice allows. There is room for both types of practitioner within the imaging department and it is important that educational, professional and registration policies can accommodate them.

**Table 7.1. Primary and secondary conclusions**

<b>Primary conclusions</b>
Graduate practitioners have a higher and more consistent level of residual knowledge of MRI than experiential practitioners have.
The key differential in residual knowledge is the general principles that underpin MRI.
Graduate practitioners are more competent in key areas of practice. This influences departmental efficiency, patient throughput and the patient experience.
How direct-entry practitioners are registered is a significant barrier to early specialisation in the UK.
<b>Secondary conclusions</b>
Neither graduate nor experiential models appear to enable learning in some aspects of MRI safety and image optimisation.
Experiential practitioners who work only in MRI could have as limited a scope of practice as that of graduate practitioners.
Practice in MRI may not be dependent on first qualifying as a radiographer.



## 7.4. SECONDARY AND UNEXPECTED FINDINGS

Although I expected to find that graduate practitioners achieve better OSCE scores, because they learn MRI via a formal programme of study, I am surprised to find that there is such a highly significant difference. This does not appear to be caused by a particularly good performance by graduate practitioners or a particularly bad performance by experiential practitioners; rather, it is mainly the result of experiential practitioners' lack of knowledge of the general principles that underpin MRI. In addition, evidence points to experiential practitioners having knowledge that is more inconsistent. My research finds that undergraduate curricula might have a more substantial impact on residual knowledge of MRI than I thought, and this raises the importance of this topic.

A secondary and unexpected finding is that experiential practitioners might be more likely to not only produce sub-optimal images but also blame poor image quality on the equipment rather than on their incorrect setting of protocol parameters. The consequences are not directly measurable, but they are important. Because of blaming the equipment, engineers are called to diagnose non-existent faults. This is costly and impacts on departmental efficiency, patient throughput and the patient experience. There may also be other hidden consequences. Practitioners who are quick to blame their tools rather than seek solutions from their own practice could threaten their professional status. This attitude might perpetuate lack of knowledge, because it does not favour the cultivation of individuals who challenge their practice and strive for improvement through education. It may also feed an organisational culture where poor practice is unquestioned and is cascaded to others in the department (Allen, 2014).

Another unexpected finding of this research is that although experiential practitioners are general practitioners in theory (because they learn a range of imaging modalities in the undergraduate radiography programme), if they specialise in MRI post-qualification they might become deskilled in other areas of practice. This results in the same limited scope of practice and inflexibility that applies to their graduate practitioner colleagues. Therefore, restricted practice might be a barrier to any form of specialisation (early or otherwise). The idea that general practice is only sustainable if a practitioner is consistently exposed to a range of imaging modalities is interesting. Clinical managers may be wrong to assume that

all general radiographers in their department are competent to work in every imaging area. There are implications in terms of rostering, cover for leave, on-call and how safe these practitioners are if they are unfamiliar with the discipline. This secondary finding may support the introduction of a specialised degree in MRI. Limited scope of practice is often the main fall-back argument for those who oppose early specialisation, but if experiential practitioners are also limited then this argument is harder to defend. The traditional distinctions between specialists and generalists are perhaps not as marked as we think.

My research finds that learning MRI via a specialised undergraduate programme may be more effective than learning MRI via the traditional experiential method. The importance of first qualifying as a radiographer was not directly tested but is implicit. The fact that none of the graduate practitioners first qualified as a radiographer but consistently scored more highly in the OSCE than experiential practitioners suggests that acquiring the core technical knowledge and skills of a radiographer may not be important to practise in MRI. It is even possible that first qualifying as a radiographer sends practitioners on an unhelpful educational pathway into MRI, because after qualifying as a radiographer they are more likely to learn MRI experientially than to be given the opportunity to complete another undergraduate programme. The significantly lower OSCE scores of the experiential practitioners in my research and in the studies of Westbrook and Talbot (2009) and Weening, Gilman and Greenidge (2012) suggest that experiential learning is not the optimal way for them to learn MRI. Furthermore, the opinion that it is not necessary to first qualify as a radiographer to practise MRI is supported by many who teach MRI in the USA. There is a consensus, echoed by some of the interview respondents in my research, that completing a degree in radiography before entering MRI practice is out-dated and has little value in the clinical setting (Weening, 2012).

## 7.5. REFLECTION ON MY JOURNEY AS A RESEARCHER

In Chapter 1, I explored what voice I intended to bring to this research and where I position myself on the teacher-researcher spectrum. I concluded that I am primarily an academic who has some experience of research and who is drawn to inquiry in the radiographic domain. My development as a researcher during this process has been significant. I have grown from an individual who is firmly embedded in the quantitative paradigm to one who can appreciate and embrace qualitative research as well. I have cultivated an interest in mixed methodology and, although I still consider myself a new mixed methodologist, I believe that undertaking this research has enabled me to make an important contribution to this field. My understanding of the research process has significantly improved throughout this journey and I am confident that it has had a considerable impact on my academic skills. I am surprised to find that there is a qualitative side to me and that this might even prove to dominate my research personality in the future.

I have enjoyed this process, but there have been several challenges along the way. Getting to grips with educational research terminology was testing. For example, it was difficult to pin down what is meant by a theoretical perspective and how this might apply to my research. Eventually I decided on an exploratory lens but left the door open for transformative outcomes. I believe that this research is successfully viewed from an exploratory perspective and that some tentative steps have been taken towards transformation. My research findings indicate that radical change might be needed, but its implementation requires input outside this study.

Decisions on when and how to merge the data were also problematic. Mixed methodology is still in its infancy and there is a lack of consensus on merging techniques. I found inspiration from the key advocates of this paradigm and referred to publications that have adopted a mixed-methodology approach. My initial intention was to connect the data at the beginning of the analysis and interpretation phase of my research to emphasise the importance I place on mixing. However, I found that making connections was not possible until I had made sense of the data and understood what they implied. I am confident that a clear mixed-methodology philosophy threads through my research. A pragmatic stance was the starting point for the development of research questions that clearly align with quantitative, qualitative and mixed-methodology outcomes. A mixed-methodology design,

consistent with a comparative perspective between quantitative and qualitative data, was chosen and the findings were viewed through lenses that are congruent with this design.

Looking back to the ideas of Jove (2011), which were explored in Chapter 1, I have become much more of a researcher than I was at the beginning of this process. I have moved a long way towards the research end of the teacher-researcher spectrum. The development of my research identity is still very much a work in progress, but I believe that I have blossomed into a confident researcher who is well prepared to contribute new knowledge in the future.

## 7.6. RECOMMENDATIONS

To draw this work to a close, suggest areas for further investigation (Table 7.2., p.254) and outline the recommendations of my research (Table 7.3., p.254), I return to the fitness framework identified in Chapter 1 (Figure 1.2., p.16). This conceptual model shows a possible disconnect between what employers require a practitioner to do (fitness for purpose), what professional and regulatory bodies expect of that practitioner for registration (fitness for practice) and what HEIs need to validate an educational programme (fitness for award) (Smith, 1998). In Chapter 1, I state that 'if the development of initial and exclusive MRI specialist education is the answer to deficiencies in current educational strategies, these three concepts must be reconnected in a meaningful way' (p. 15). At the end of my research, it seems important to reflect on this model once again.

The findings of this study appear to fly in the face of current professional policy in the UK. Although the HCPC require undergraduate programmes to provide radiographers with enough working knowledge to only assist in MRI examinations, the SCoR sees MRI as a core skill of a radiographer (2013a). It seems that core skills are difficult to acquire unless there is sufficient room in the curriculum to teach them. At present, the only reference to MRI in the recommended BSc radiography curriculum is some basic theory of MRI and techniques for standard examinations (SCoR, 2013a). Although this is likely to be sufficient to enable a practitioner to assist in MRI examinations, it does not align with the skills and competencies required of an entry-level MRI practitioner (Skills for Health, 2008), which reflect much broader and deeper knowledge and practice. Therefore, it appears that the BSc radiography programme may not sufficiently equip a radiographer to practise MRI to the required level according to the national occupational standards. There appears to be an educational policy gap in terms of the best way to educate MRI practitioners when they first enter practice. Currently, the gaps in learning are mainly bridged by experiential learning post-qualification; however, as my research finds, this does not seem to be the best way to facilitate residual knowledge. As experiential practitioners do not have the necessary theoretical grounding in MRI, they find it hard to make connections between theory and practice. Furthermore, the quality of the experiential training they receive from their peers is untested and may perpetuate bad practice (Allen, 2014).

It would seem, therefore, that undergraduate programmes in radiography are failing those who wish to specialise in a modality, such as MRI. Despite the policies of the UK professional body, HEIs cannot sufficiently deliver because the curricula are overcrowded. This is probably a reflection of the increasingly diverse working practices of radiographers and the progressive technical advances of imaging equipment. Undergraduate programmes in radiography may provide breadth, but there does not seem to be room for enough depth in specialist image modalities. In a specialty, such as MRI, depth is important. The requirements of employers also focus on practitioners who are skilled, who need minimal additional training and who can 'hit the ground running' when they start to practise. These expectations may be met in general radiographic practice but are perhaps less likely to be met in MRI, because the undergraduate radiography curriculum does not adequately prepare practitioners. Additional training, usually in the form of on-the-job learning, is the usual course; however, as this research shows, this is not necessarily the best educational method. Post-graduate courses are seen as the best educational pathway to develop specialist skills in MRI. However, these courses require support in terms of funding and study time and not all practitioners are suited to master's level learning. There are already many unregistered practitioners in MRI practice who may not wish to qualify as a radiographer and a policy vacuum exists on how best to educate these individuals.

It is crucial that HEIs and professional and regulatory bodies are accountable to employers and patients. From a patient's perspective, HEIs have a responsibility to ensure that practitioners have the necessary knowledge and skills to practise safely. Regulatory bodies have a responsibility to register those who have demonstrated their competence to practise. In radiography, this is assumed by successfully completing an undergraduate degree in radiography and through continuing professional development (CPD). Currently, there are no formal checks on the competency of MRI practitioners in the UK. Unlike in the USA, there is no registry examination and CPD assessment is random. Therefore, there is no reliable mechanism for ensuring that experiential practitioners have sufficient knowledge and skills to practise competently. My research, corroborated by the previous research by Westbrook and Talbot (2009), suggests that this knowledge cannot be assumed.

One of the identified co-variates is whether assessment might have influenced the results. In this study, data on whether graduate or experiential practitioners had

completed the ARRT MRI certification examination were not collected. However, there is a clear opportunity for further research, as studying for and completing this examination might have more impact on residual knowledge than the way in which MRI is learned. If further research suggests that this might be the case, it could force educational and professional bodies to reflect upon the effectiveness of current assessment methods in the UK. At present, the HCPC randomly selects a small number of radiographers for CPD. They are required to submit a CPD profile of their educational activities and provide a statement on their learning needs, their learning activities, what evidence they have supplied and what they have learned (HCPC, 2016b). This system may not, however, sufficiently evaluate the knowledge and skills of an MRI practitioner and a different approach, similar to the ARRT certification examination, might be valuable (Westbrook and Talbot, 2009). Further research that correlates OSCE scores with completion of the ARRT MRI certification examination could inform this debate. Thus, a recommendation of this research is that the UK professional body works with HEIs and service users to develop an evidence-based cohesive policy on how best to educate MRI practitioners. A form of standardised assessment for all MRI practitioners might be required.

Several professional benefits to early specialisation in MRI are identified that have an impact on the service-user experience. From an employer's perspective, practice that is more knowledgeable increases departmental efficiency and patient throughput and reduces costs. Practitioners with a high level of residual knowledge are more capable of performing MRI scans. They are more likely to have the knowledge and skills needed to make appropriate scan parameter selections and optimise image quality and data acquisition. Patients are possibly recalled less often for repeat examinations. A more knowledgeable practitioner is also able to adapt the examination to the patient and their pathology. There is a clear opportunity to investigate patients' views on specialism and see whether the findings of this research are supported from the patient perspective. Very little appears to have been published on this topic. Literature exists with reference to breast cancer and palliative care (Yang, Ewing and Booth, 2012; Firn, Preston and Walshe, 2016) but there is none specific to radiography. Capturing the patient voice could inform the specialist versus generalist debate and might influence how MRI practitioners are educated in the future.

From an educational perspective, therefore, my research challenges whether experiential learning methods are fit for purpose and advocates that learning MRI via a specialised undergraduate degree is more successful in terms of facilitating knowledge, bridging the theory-practice gap and improving the service-user experience. On this basis, the introduction of an undergraduate degree has firm foundations and questions the current educational framework in the UK. My research recommends that a rethink in how specialisms, such as MRI, are taught is justified and that an adjustment in educational and professional policy might be needed. I have made comparisons between undergraduate and experiential learning in this research. There is merit, however, in extending this inquiry to those who have learned MRI in other ways. For example, an area for further research would be to use the OSCE to assess those who have acquired a postgraduate degree in MRI and compare the results with those of this research. This should enable an appraisal of undergraduate and postgraduate learning in MRI and could provide some additional insights into what level of education is most appropriate for entry-level and advanced practice. This data might also permit a deeper analysis of the merits or otherwise of first qualifying as a radiographer.

Another recommendation of my research is that employers re-evaluate the working practices of radiographers employed in specialist imaging modalities, such as MRI, especially those who are sometimes utilised in other imaging modalities. The restricted scope of practice of practitioners who enter MRI direct is important, especially in small departments, where the number of staff is limited and they are often required to work in several modalities. In larger departments, employers are perhaps more likely to favour those who, in theory, they can deploy in any area of the imaging department, and this sentiment is voiced in my research. However, this study also suggests that once a practitioner begins to work in a discrete area of practice, they become deskilled. Limited scope of practice is a feature of all specialisation, regardless of how that specialism is learned. Therefore, the assumption that all radiographers can work in all areas of the imaging department may be false. In addition, this view does not take the findings of this research into account. Graduate practitioners, although limited in their scope of practice, have more knowledge of MRI and bring significant benefits to the department.

The registration of direct-entry practitioners is likely to be a major barrier to the introduction of an undergraduate degree in MRI in the UK. Nursing and midwifery graduates are permitted to register voluntarily in a discrete area of practice after



completing approved programmes of study. A similar precedent can be found in in Australia and the USA, where direct entry into ultrasound practice without first qualifying as a radiographer is permitted. The Australian Sonographer Accreditation Registry was set up by the Australian Institute of Ultrasound to provide a register for these practitioners. There is an expectation that entry-level practitioners who complete an undergraduate programme in ultrasound, but who are not qualified as radiographers, are eligible for entry in the Registry of Accredited Medical Sonographers, as long as they have achieved particular competencies (ASA, 2011).

The SCoR and HEE are reviewing the need for ultrasound undergraduate education and registration in the UK (SCoR, 2016). This is in response to an acute shortage of sonographers in the UK and recognition that many different healthcare professionals, such as midwives, doctors, nurses and radiographers, already perform ultrasound examinations. Training and education in ultrasound is varied. In a recent survey, HEE assessed several alternative educational routes into sonography, including direct entry, and the University of Birmingham is currently developing an undergraduate degree in ultrasound (SCoR, 2016). The introduction of this programme would permit standardisation but might also allow direct entry into the profession without the need to first qualify as a radiographer. However, graduates with a degree in ultrasound will not be eligible to register with the HCPC, because there is currently no legal requirement for sonographers in the UK to be registered and the title 'sonographer' is not protected in law (SCoR, 2016). Although the HCPC might support the registration of other titles, current government policy does not permit this. A government paper, *Enabling Excellence – Autonomy and Accountability for Healthcare Workers, Social Workers and Social Care Workers* (2011) states that government policy is to limit the registration of new groups unless there are exceptional circumstances or voluntary registers are insufficient to manage the risk (HCPC, 2016a).

The SCoR currently administers a voluntary register of assistant practitioners who work in MRI and other fields, such as sonography. Therefore, it is presumed that it could do the same for direct-entry MRI practitioners who are not eligible to register with the HCPC. However, assistant practitioners currently work under the supervision of registered professionals, which is a requisite for entry onto the voluntary register. If direct entry into MRI practice after completing an undergraduate degree were established in the UK, the expectation would be that

graduate practitioners would work autonomously, as they do in the USA. Therefore, a voluntary register of supervised practitioners would not be appropriate. The SCoR maintains that a lack of statutory regulation is not in itself a barrier to employing graduate practitioners. However, employers may be reluctant to take on untested and unregulated practitioners. Even if the SCoR were to establish a voluntary register for direct-entry MRI practitioners, it would be inappropriate to enable students to obtain a degree in MRI if employers were unwilling to engage them upon their graduation. In addition, legal restrictions, imposed by government, are likely to be placed on MRI practitioners who are not statutorily registered. They would not be able to refer patients for examinations involving ionising radiation or administer contrast agents, for example (SCoR, 2013b).

A wider issue is the management of risk for individuals on a voluntary register and their patients. Whom do these registers protect and what power do they have compared with a government-backed regulatory system? What protection do patients have from negligent individuals on a voluntary register? Government policy to restrict the regulation of new groups and pass this accountability on to professional bodies is acknowledged, but it seems to be important to ensure that the healthcare workforce is properly regulated so that the workforce and their patients are protected. This research recommends that the UK government, in consultation with the UK professional body and service users, develops a policy for the registration of imaging professionals who are not already registered with the HCPC. A potential avenue for further research is to extend the qualitative strand of this study by capturing the perspectives of a range of healthcare professionals in the UK. There is merit in exploring the views on early specialisation held by clinical managers in the NHS and the private sector in addition to radiographers, assistant practitioners and others who are in a position to influence policy. This is an important step towards gaining a better understanding of the feasibility of introducing an undergraduate degree in MRI in the UK.

Disenchantment with the traditional models of education is reported by students, who are beginning to question the quality and effectiveness of their experiences (Allen, 2014). Educationalists need to adapt to new models of healthcare, the success of which depends upon a workforce that has the right skills and knowledge to deliver them (National Health Service, 2014). There is a risk that practitioners will confine themselves to out-dated modes of delivery unless there are radical changes to the way in which they are educated. HEE (2014) has pledged that it will work

with stakeholders to identify the education and training needs of the workforce so that practitioners are equipped with the skills and flexibilities needed; this includes the development of specialist roles. However, there is a policy vacuum, with no clear direction on what level imaging specialists should be educated to in the future or how curricula could be designed to capture foundation and specialist knowledge. Therefore, the final recommendation that emerges from this research is that HEIs consider the introduction of a specialised undergraduate degree in MRI as part of their educational provision. These curricula should be designed to ensure that graduate practitioners can make the necessary links between theory and practice, and careful thought needs to be given to how they align and integrate with existing radiographic programmes. However, new ways of facilitating the learning of experiential MRI practitioners must also be explored. The deficiencies in experiential practitioners' residual knowledge in this research, supported by similar findings in the same type of learner in other studies, draws attention to the fact that experiential educational provision needs to be improved.

So, does initial and exclusive specialisation in MRI via an undergraduate degree connect the components of the fitness framework in a meaningful way? I think the answer is that it could, but changes in policy are required. In the cases of ultrasound and midwifery, where there are examples of direct entry into these professions, the drivers of change were new applications and increasing demand for services that could not be met with existing staffing levels. Professional and registering bodies responded by making policy adjustments, and these went hand in hand with changes in education (Cowling, 2013). Similar forces for change are present in MRI. The increasing demand for MRI scans, coupled with an ageing population, may prove to be an instrument of change that influences the way in which MRI practitioners are educated in the future. The needs of service users are vital and, in my view, they are the most important part of this process. Their requirements and expectations should take precedence over educational and professional policy.

This research may also highlight how best to identify and label MRI practitioners. The title *radiographer* was initially used to reflect the use of X-radiation; therefore, it is probably not relevant in MRI, which uses radio waves and magnetic fields. In some countries, such as the USA, the term *radiologic technologist* is attributed to anyone working in an imaging department, regardless of the modality and the way in which it is learned. Technologists are differentiated from technicians, who

maintain equipment but are not usually educated to degree level (Young, 2008). Although the role of the radiographer bridges technology and medicine (Belinsky et al., 2003), the use of the term *technologist* has been resisted in the UK, because it sits too close to technician-level practice. There is even less consensus in MRI on how to refer to MRI practitioners who are not radiographers. My research challenges this even further, because it shows that it may not be necessary to be a radiographer to practise MRI. In fact, being a radiographer may act as a barrier to learning MRI effectively.

A final consideration is what effect developing technology might be having on learning. In my experience, advances in equipment software and scanner hardware are leading to increased use of built-in protocols, which require less input from practitioners. Manufacturers are promoting the increasingly sophisticated automated features of MRI scanners; however, it is possible that these features are overriding learning and deskilling MRI practitioners, because they remove the requirement for practitioners to make their own parameter-selection choices. This could be one of the reasons why the scores in Section 5, particularly the questions relating to parameter selection, are poor for graduate and experiential practitioners alike. This raises further questions about radiographic identity. In the future, as scanners become even more technologically advanced and require even less input from knowledgeable MRI practitioners, the legitimacy of the professional status of imaging practitioners could be compromised and demotion to technician status is possible.

Tables 7.2. and 7.3. (p.254) summarise the suggested areas for further research and the recommendations made by this study. The recommendations have been mapped to those related to HEIs, service users and regulatory and professional bodies in an attempt to link them to the fitness framework. However, it is very likely that a collaborative initiative between all three agencies is required to fill the current policy vacuum.

**Table 7.2. Agenda for further research**

<b>Educational</b>	Comparison of OSCE scores between graduate practitioners and those who learn MRI via a postgraduate programme.
	Correlation of the OSCE scores with successful completion of the ARRT certification examination in MRI.
	Analysis of the effect that technological advances might be having on learning and knowledge.
<b>Professional</b>	Exploration of the patient's voice on specialism and general practice.
	Extended investigation of a range of healthcare professionals' views on early specialisation and registration of direct-entry practitioners in the UK.

**Table 7.3. Summary of recommendations**

<b>Academic (HEIs)</b>	HEIs should consider the introduction of a specialised undergraduate degree in MRI. The curriculum needs to align with, and integrate with, existing radiographic programmes.
	Undergraduate MRI curricula must be designed to ensure that students can make easy links between theory and practice.
	Experiential practitioners' educational provision must be improved to reinforce practice.
<b>Practice (service users)</b>	Employers need to re-evaluate the working practices of radiographers employed in specialist imaging modalities, such as MRI, especially those who are sometimes utilised in other imaging modalities.
	The patient's voice on how best to educate specialist imaging professionals should be heard.
<b>Policy (professional body, government and HEE)</b>	The professional body in the UK, in consultation with HEIs and service users, needs to develop a cohesive policy on how best to educate MRI practitioners, including some form of standardised assessment.
	The UK government, in consultation with the professional body and service users, should develop a policy for the registration of imaging professionals who are not already registered with the HCPC.

## 7.7. ORIGINALITY AND CONTRIBUTION TO KNOWLEDGE

The title of my thesis was chosen to reflect the potential for this research to shed new light on the education of MRI practitioners. I am confident that this has been achieved. However, I acknowledge that further research is needed to discover whether learning MRI at undergraduate level is the best way overall.

This study makes original contributions to knowledge in the following ways (see Table 7.4.). It is thought to be the first that compares the knowledge of graduate and experiential practitioners as I have defined them; therefore, it is the first to assess whether it is necessary to qualify as a radiographer to practise MRI. I also believe it to be the first study to use a mixed methodology to explore the professional and educational aspects of early specialisation in radiography. Finally, it is the only exploration so far of the feasibility of introducing direct entry into MRI practice via a specialised undergraduate degree in the UK.

**Table 7.4. Summary of the original contribution to knowledge made by this research**

<b>This study makes original contributions to knowledge in the following ways:</b>
1. It compares the knowledge of MRI of radiographers and direct-entry practitioners.
2. It investigates whether it is necessary to first qualify as a radiographer to practise MRI.
3. It explores the professional benefits and barriers to early specialisation in radiography.
4. Using a mixed-methodology approach, it investigates the feasibility of direct entry into an imaging specialism via an undergraduate degree in MRI in the UK.

If there is to be a revolution in how specialisms, such as MRI, are taught, significant political hurdles must be overcome. This must be accompanied by changing attitudes to what constitutes the core skills of a radiographer. The most substantial hurdle is probably registration. If direct entry into MRI practice is to become a reality in the UK, either employers need to relax their expectation that all MRI practitioners are formally registered or there needs to be a change in government policy in this regard. The likelihood is that service users will be the driver for change in the UK.

Currently, there is a critical shortage of MRI practitioners and there is anecdotal evidence that employers are seeking new and innovative solutions.

The findings of my research are persuasive. Although future studies are needed, the work done here starts an important conversation about how best to educate imaging specialists. There is a policy vacuum surrounding specialist education in radiography; therefore, my research is important, timely and relevant.

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## LIST OF APPENDICES

## APPENDIX 1: Participant information forms



Anglia Ruskin  
University

Cambridge Chelmsford Peterborough

### PARTICIPANT INFORMATION SHEET: MRI PRACTITIONER

My name is Catherine Westbrook I am a senior lecturer in Magnetic Resonance Imaging and Medical Education, at Anglia Ruskin University in Cambridge, UK. I am currently undertaking a research project entitled:

#### **“Jack of all trades or Master of one? - Shedding New Light on MRI Practitioner Education using a Mixed Methods Approach”**

Thank you for showing interest in taking part in my research project. Here are the answers to some questions you may have about participating.

#### **What is the purpose of the research?**

The aim of my research is to investigate how MRI practitioners are educated. I am specifically exploring whether it is necessary to first qualify as a diagnostic radiographer before specialising in MRI. The information I get from this study should increase our understanding of whether early specialisation is a good thing or not for MRI practice.

#### **Who is organising the research?**

This research is being conducted and organised by me, Catherine Westbrook, under the auspices of Anglia Ruskin University Cambridge UK in collaboration with Universities in the USA who run a specialised MRI programme.

#### **What will happen to the results of the study?**

The results of this study will be used in my doctoral thesis and may be published in some research journals. I may also present the results of this study at conferences.

#### **Contact for further information**

[Catherine.westbrook@anglia.ac.uk](mailto:Catherine.westbrook@anglia.ac.uk):

This email address can be used to contact me at any time throughout the project and can be used to ask me any further questions that you may have.

The local contact is:

My first supervisor is: Hazel Wright [hazel.wright@anglia.ac.uk](mailto:hazel.wright@anglia.ac.uk)

#### **Why have I been invited to take part?**

You have been chosen to take part in this study because you are either a qualified radiographer and have learnt MRI “on the job” or you are not a qualified radiographer and have learned MRI via a specialised MRI programme.

#### **Can I refuse to take part?**

Participation in this study is entirely voluntary. It is up to you to decide whether to participate or not.

#### **Can I withdraw at any time, and how?**

You are free to withdraw at any time, without giving a reason by completing a form and returning it to me.

#### **What will happen if I agree to take part?**

This is called a mixed methods study, which means that there are two parts.

*Part one* involves completing a timed multiple-choice quiz. This quiz is designed to test your understanding of MRI concepts and there is only one correct answer to each question. The purpose of the quiz is to find out what type of knowledge MRI practitioners possess and therefore some of the questions are quite difficult. If you don't know the answer to a question just miss it out. This quiz consists of 5 parts, each comprising 20 questions. You will be given 10 minutes to answer each section. Full instructions will be given to you before you start the quiz and I will be present at all times in case you are not sure what to do.

**It is very important that you do not revise anything before the test. Your Individual score is not important for this study and revising might make my results misleading.**

*Part two* involves a short interview for a few people taking part in this study. If you agree to participate I may not select you but if I do, I will ask you questions relating to your experiences and opinions on the professional benefits and problems of early specialisation in MRI. I will conduct the interviews.

Each part should take no more than 60 minutes.

**Are there any risks involved?**

There are no risks involved in taking part in this study.

**What will happen to any information collected from me?**

The test scores will be compared to see if there is relationship between knowledge of MRI and the way in which it is learned. Information from interviews will be used to explore the professional benefits and barriers to early specialisation in MRI.

**Are there any benefits from taking part?**

I cannot promise that the study will help you personally but the information I get from this study should increase our understanding of whether early specialisation is a good thing or not for MRI practice.

**How will my participation in the project be kept confidential?**

All information collected about you during the course of the research will be kept strictly confidential. Your name will not be used and your identity will remain anonymous. You will be given a unique identifying number. This number, rather than your name will be used throughout the study. Any information linking your name to the unique identifying number will be stored on a password-protected computer and this will be destroyed as soon as the data has been collected. All data from the quiz and the interview will be de-identified and stored on my computer where it will be protected with a password known only to me and destroyed after a period of three years. The results of the quiz will not be given to anyone and neither the quiz score nor any responses you give in the interviews will be shared with anyone, including your employers. In order to ensure your anonymity, I will not be able to tell you your quiz score.

**What do I do now?**

If you are happy to take part in this project, please read and sign the accompanying consent form.

***You will be given a copy of this sheet and the consent form to keep.***

## PARTICIPANT INFORMATION SHEET: STAKEHOLDER



Anglia Ruskin  
University

Cambridge Chelmsford Peterborough

My name is Catherine Westbrook I am a senior lecturer in Magnetic Resonance Imaging and Medical Education, at Anglia Ruskin University in Cambridge, UK. I am currently undertaking a research project entitled:

### **Shedding New Light on MRI Practitioner Education: Jack of all Trades or Master of One?**

Thank you for showing interest in taking part in my research project. Here are the answers to some questions you may have about participating.

#### **What is the purpose of the research?**

The aim of my research is to investigate how MRI practitioners are educated. I am specifically exploring whether it is necessary to first qualify as a diagnostic radiographer before specialising in MRI. The information I get from this study should increase our understanding of whether early specialisation is a good thing or not for MRI practice.

#### **Who is organising the research?**

This research is being conducted and organised by me, Catherine Westbrook, under the auspices of Anglia Ruskin University Cambridge UK in collaboration with Universities in the USA who run a specialised MRI programme.

#### **What will happen to the results of the study?**

The results of this study will be used in my doctoral thesis and may be published in some research journals. I may also present the results of this study at conferences.

#### **Contact for further information**

[Catherine.westbrook@anglia.ac.uk](mailto:Catherine.westbrook@anglia.ac.uk):

This email address can be used to contact me at any time throughout the project and can be used to ask me any further questions that you may have.

The local contact is:

My first supervisor is: Hazel Wright [hazel.wright@anglia.ac.uk](mailto:hazel.wright@anglia.ac.uk)

#### **Why have I been invited to take part?**

You have been chosen to take part in this study because you are a Manager, Radiologist or Radiography Professional with an interest in the outcomes of this research.

#### **Can I refuse to take part?**

Participation in this study is entirely voluntary. It is up to you to decide whether to participate or not.

**Can I withdraw at any time, and how?**

You are free to withdraw at any time, without giving a reason by completing a form and returning it to me.

**What will happen if I agree to take part?**

This is called a mixed methods study, which means that there are two parts. You have been asked whether you would like to participate in Part two of this study. This involves an interview where I will ask you questions relating to your experiences and opinions on the professional benefits and problems of early specialisation in MRI. I will conduct the interviews. This should take no more than 60 minutes.

**Are there any risks involved?**

There are no risks involved in taking part in this study.

**What will happen to any information collected from me?**

Information from interviews will be used to explore the professional benefits and barriers to early specialisation in MRI.

**Are there any benefits from taking part?**

I cannot promise that the study will help you personally but the information I get from this study should increase our understanding of whether early specialisation is a good thing or not for MRI practice.

**How will my participation in the project be kept confidential?**

All information collected about you during the course of the research will be kept strictly confidential. Your name will not be used and your identity will remain anonymous. All data from the interview will be de-identified and stored on my computer where it will be protected with a password known only to me and destroyed after a period of three years. The responses you give in the interview will not be shared with anyone, including your employers.

**What do I do now?**

If you are happy to take part in this project, please read and sign the accompanying consent form.

***You will be given a copy of this sheet and the consent form to keep***

## APPENDIX 2: Consent forms



### Consent Form

#### Shedding New Light on MRI Practitioner Education: Jack of all Trades or Master of One?

Name of Researcher: Catherine Westbrook

#### Please initial box

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason. ☐
3. I understand that any information given by me may be used in future reports, articles or presentations by the researcher. ☐
4. I understand that my name will not appear in any reports, articles or presentations. ☐
5. I agree to take part in the above study. ☐

_____	_____	
Name of Participant	Date	Signature

_____	_____	
Researcher	Date	Signature

**When completed, please return. One copy will be given to the participant and the original to be kept in the file of the researcher at: Anglia Ruskin University UK**



## APPENDIX 3: Ethics approval form



Anglia Ruskin  
University

Cambridge Chelmsford Peterborough

**Ref:** AHM/DREP/14-026

**Enquiries:** DREP-AHM@anglia.ac.uk

**Direct Line:** 0845-196-2546

**Date:** 19<sup>th</sup> September 2014

**Chelmsford Campus**

Bishop Hall Lane

Chelmsford

CM1 1SQ

T: 0845 271 3333

Int: +44 (0)1245

[www.anglia.ac.uk](http://www.anglia.ac.uk)

493131

Catherine Westbrook

Dear Catherine,

Re: Application for Ethical Approval

**Project Number:** AHM/DREP/14-026

**Project Title:** **Shedding New Light on MRI Practitioner Education:  
Jack of all Trades or Master of One?**

**Principal Investigator:** Catherine Westbrook

Thank you for your application for ethical approval which was considered by the Faculty (of Health, Social Care & Education) Departmental Research Ethics Panel (DREP) for Allied Health and Medicine week commencing 12<sup>th</sup> June 2014

**I am pleased to inform you that you have satisfied the criteria for your research proposal and this is approved** by the Faculty Research Ethics Panel under the terms of Anglia Ruskin University's *Policy and Code of Practice for the Conduct of Research with Human Participants*. Approval is for a period of three years from 19<sup>th</sup> September 2014.

It is your responsibility to ensure that you comply with Anglia Ruskin University's Policy and Code of Practice for Research with Human Participants and specifically:

- The procedure for submitting substantial amendments to the committee, should there be any changes to your research. You cannot implement these changes until you have received approval from FREP for them.
- The procedure for reporting adverse events and incidents.

- The Data Protection Act (1998) and any other legislation relevant to your research. You must also ensure that you are aware of any emerging legislation relating to your research and make any changes to your study (which you will need to obtain ethical approval for) to comply with this.
- Obtaining any further ethical approval required from the organisation or country (if not carrying out research in the UK) where you will be carrying the research out. Please ensure that you send the FREP Secretary copies of this documentation.
- Any laws of the country where you are carrying the research out (if these conflict with any aspects of the ethical approval given, please notify FREP prior to starting the research).
- Any professional codes of conduct relating to research or research or requirements from your funding body (please note that for externally funded research, a project risk assessment must have been carried out prior to starting the research).
- Notifying the FREP Secretary when your study has ended.

Information about the above can be obtained on our website at:

<http://web.anglia.ac.uk/anet/rdcs/ethics/index.phtml/>

<http://web.anglia.ac.uk/anet/faculties/hsce/research-ethics.phtml>

Please also note that your research may be subject to random monitoring by the Committee.

Please be advised that, if your research has not been completed within one year, you will need to apply to our Faculty Research Ethics Panel for an extension of ethics approval prior to the date your approval expires. The procedure for this can also be found on the above website.

Should you have any queries, please do not hesitate to contact me. May I wish you the best of luck with your research.

Yours sincerely,



**Dr Sarah Redsell (Chair)**

For the Faculty (of Health, Social Care & Education) Departmental Research Ethics Panel

T: 0845 196 2546

E: sarah.redsell@anglia.ac.uk

## APPENDIX 4: OSCE questions and answers

(in blue)

Welcome to the MRI Quiz! The aim of this quiz is to test your knowledge of some key concepts of MRI.

**This quiz is divided into 5 sections of 20 questions each. You will be given 8 minutes to answer each section.**

It is very important that everyone has the same amount of time to answer the questions. At the end of each 8 minute interval, an alarm will sound. On hearing the alarm, please put down your pen and wait for the invigilator to collect your answers. The next set of questions will then be given to you. Do not start answering the questions until told to do so by the invigilator.

For most questions you will be asked to select one answer only but for some questions you will be asked to write a short answer of a few words only. Please write clearly.

Please do not talk during this quiz or use books or other materials. I am comparing the scores between two groups of people so there is no pass or fail score. Some questions are quite difficult because I want to test a range of knowledge, but don't worry! If you do not know the answer to a question please just leave it blank.

If you do not understand a question or do not understand what you need to do, please raise your hand and an invigilator will assist you.

Many thanks for participating.

**Participant Number:**

**Number of Years Experience of MRI since qualification:**

**SECTION 1**  
**QUESTIONS 1 to 20**

**MRI SAFETY AND MRI ANATOMY AND PATHOLOGY**

<p><b>QUESTIONS 1, 2, 3, and 4:</b></p> <p><b>TICK IN THIS COLUMN</b></p> <p><b>There are certain absolute contraindications to MRI. Choose the FOUR (4) most likely contraindications from the following list.</b></p> <p><b>SELECT ONLY FOUR ANSWERS</b></p>	
<input type="checkbox"/>	pregnancy
<input type="checkbox"/>	weight too low
<input type="checkbox"/>	claustrophobia
<input checked="" type="checkbox"/>	cardiac pacemaker
<input type="checkbox"/>	tattoo
<input type="checkbox"/>	unable to remove wedding ring
<input checked="" type="checkbox"/>	cochlear implant
<input type="checkbox"/>	epilepsy
<input type="checkbox"/>	artificial heart valve
<input type="checkbox"/>	unconscious patient
<input type="checkbox"/>	artificial hips
<input type="checkbox"/>	breast implants
<input type="checkbox"/>	body piercing
<input checked="" type="checkbox"/>	intra-ocular foreign body
<input checked="" type="checkbox"/>	ferrous cerebral aneurysm clip
<input type="checkbox"/>	parkinsons disease
<input type="checkbox"/>	false eye
<input type="checkbox"/>	K nail in Femur
<input type="checkbox"/>	patient unable to lie flat

<b>QUESTION 5:</b>	
<b>What are the SI units used to measure RF energy absorption by the patient (Specific Absorption Rate).</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	joules/second
	watts/second
	milliseverts
	watts/kilogram
	watts/cubic centimeter

<b>QUESTION 6:</b>	
<b>With regard to magnetic field strength, non-screened personel are not permitted to cross a certain threshold. What is this known as?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	0.5 gauss line
	0.5 tesla line
	5 gauss line
	5 tesla line
	1 gauss line

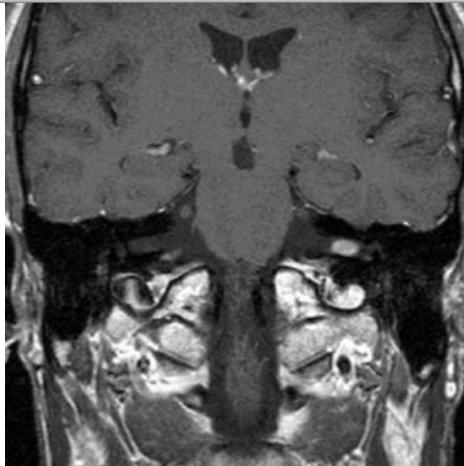
<b>QUESTION 7:</b>	
<b>You are asked to MRI scan an unborn fetus. In the interests of safety when entering the patient details which of the following would you provide?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	mothers normal weight
	estimated fetus weight
	estimated fetal age
	combined weight of mother and fetus
	estimated weight of mother

<b>QUESTION 8:</b>	
<b>In the context of MRI safety what does the SAR stand for?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	standard acquisition rate
	specific absorption ratio
	standard absorption ratio
	specific absorption rate
	specific acquisition rate

<b>QUESTIONS 9 and 10:</b>	
<b>If it can be definitely ascertained that a patient had an MRI scan yesterday at a neighboring hospital and has had no surgery or injuries since then. Give TWO (2) reasons why it might NOT be safe to scan them today.</b>	
<b>WRITE YOUR ANSWERS IN THE BOXES BELOW</b>	
<b>reason 1</b>	different field strengths
<b>reason 2</b>	overnight positive pregnancy test

**QUESTION 11:**

**What pathology is shown in this image?**

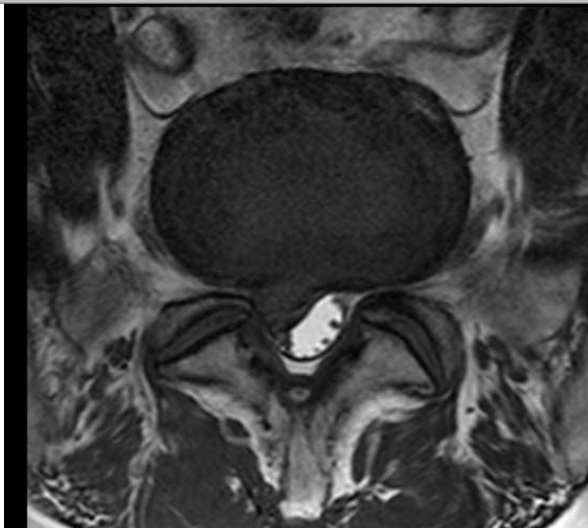


**write your  
answer here**

acoustic neuroma

**QUESTION 12:**

**What pathology is shown in this image?**

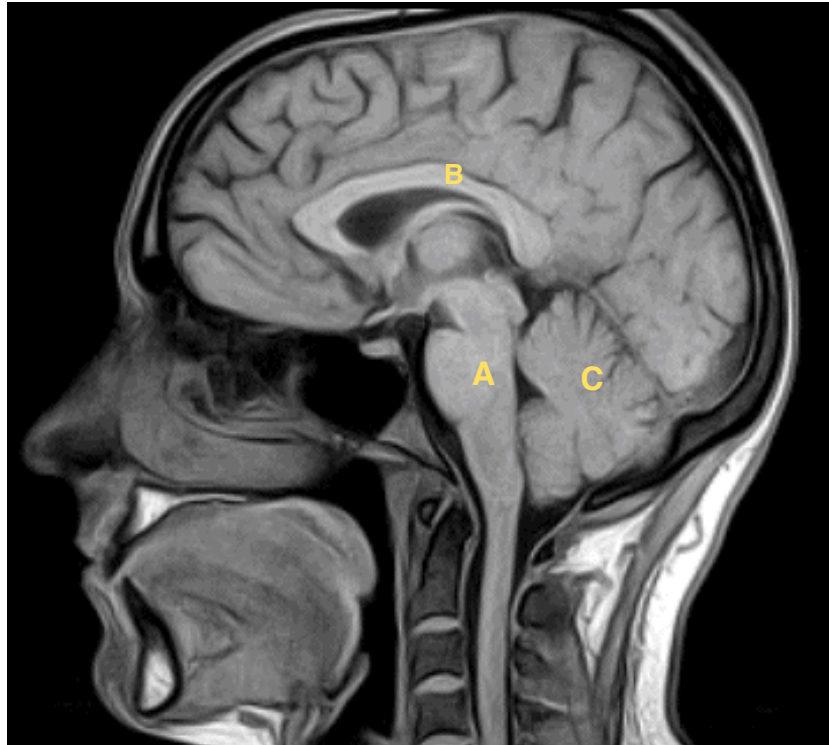


**write your  
answer here**

prolapsed intervertebral disc

**QUESTIONS 13,14 and 15:**

**Identify the labeled structures?**

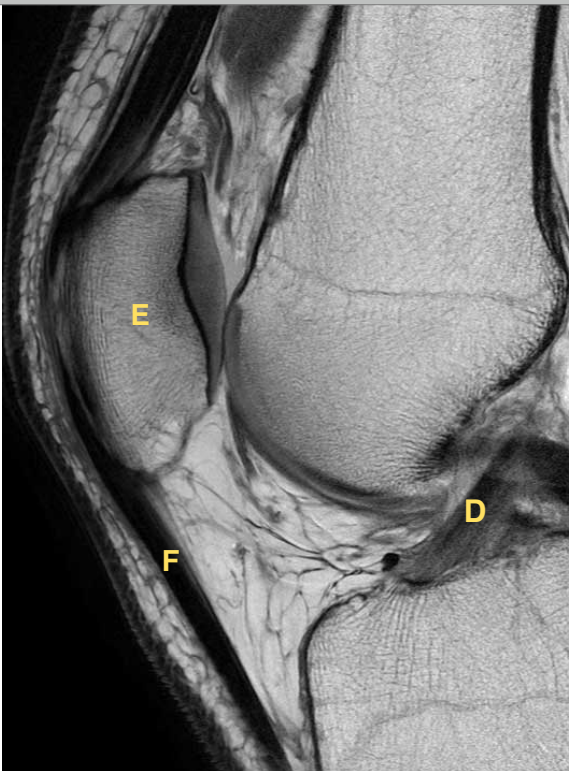


<b>Structure A</b>	pons
<b>Structure B</b>	corpus callosum
<b>Structure C</b>	cerebellum



QUESTIONS 16,17 and 18:

Identify the labeled structures?



**Structure D** anterior cruciate

**Structure E** patella

**Structure F** patella tendon

**QUESTION 19:**

**What pathology is shown in this image?**



**write your  
answer here**

syrinx ( will also accept Arnold Chiari)

**QUESTION 20:**

**What pathology is shown in this image?**



**write your  
answer here**

meniscal tear (will also accept bucket handle tear)

## SECTION 2

### QUESTION 21 to 40

#### GENERAL PRINCIPLES

<b>QUESTION 21:</b>	
<b>What is the name given to a positively charged nucleon of an atom?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input checked="" type="checkbox"/>	proton
<input type="checkbox"/>	neutron
<input type="checkbox"/>	spin up
<input type="checkbox"/>	spin down
<input type="checkbox"/>	electron

<b>QUESTION 22:</b>	
<b>What is the MR active nucleus used in MRI scanning?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input type="checkbox"/>	helium
<input checked="" type="checkbox"/>	hydrogen
<input type="checkbox"/>	oxygen
<input type="checkbox"/>	carbon
<input type="checkbox"/>	nitrogen

<b>QUESTIONS 23 and 24:</b>	
<b>Give TWO (2) reasons why this type of nucleus is used.</b>	
<b>Reason 1</b>	abundance in the human body
<b>Reason 2</b>	large magnetic moment

**QUESTIONS 25 and 26:**

**Name TWO (2) factors that determine the precessional frequency of an MR active nucleus.**

<b>Factor 1</b>	strength of Bo
<b>Factor 2</b>	gyromagnetic ratio or constant

**QUESTION 27:**

**What is the SI unit of frequency?**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**

**TICK IN THIS COLUMN**

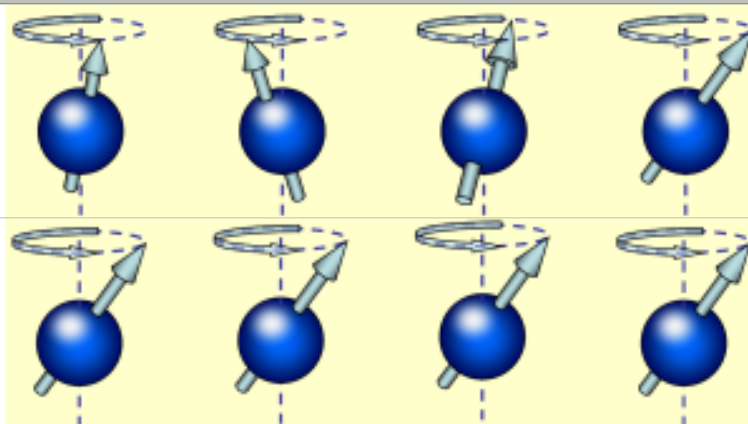
	watt
	joule
	<b>hertz</b>
	ampere
	newton

**QUESTION 28:**

**Which row of spins exhibits phase coherence (top or bottom)?**

**TOP**

**BOTTOM**



**write your answer here**

bottom row

<b>QUESTION 29:</b>  <b>Spins aligned in the anti-parallel direction are said to be in which energy state?</b>  <b>TICK IN THIS COLUMN</b>	
<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	low
	zero
	equal
	medium
	high

<b>QUESTION 30:</b>  <b>Resonance occurs when two objects do which of the following?</b>  <b>TICK IN THIS COLUMN</b>	
<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	remain stationary
	one oscillates and the other is stationary
	both oscillate but at different frequencies
	both oscillate at the same frequency
	both stretch in the same direction

<b>QUESTIONS 31and 32:</b>  <b>When a patient is exposed to B0 which of the TWO (2) following statements is FALSE?</b>  <b>TICK IN THIS COLUMN</b>	
<b>SELECT TWO FALSE ANSWERS</b>	
	hydrogen nuclei gain and lose energy
	the magnetic moments of hydrogen precess around B0
	hydrogen nuclei align with B0
	some hydrogen nuclei gain energy and retain it.
	the magnetic moments of hydrogen align with B0

<p><b>QUESTION 33:</b></p> <p><b>The Net Magnetic Vector (NMV) is made up of which of the following?</b></p> <p><b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b></p>	
<b>TICK IN THIS COLUMN</b>	
	the magnetic moments of all the spins
	magnetic moments of just the excess number of parallel spins
	the magnetic moments of just the parallel spins
	the magnetic moments of just the anti-parallel spins
	the magnetic moments of out of phase spins

<p><b>QUESTION 34:</b></p> <p><b>The gyromagnetic constant of hydrogen is?</b></p> <p><b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b></p>	
<b>TICK IN THIS COLUMN</b>	
	28.23 MHz/T
	42.57 MHz/T
	63.86 MHz/T
	127.72 MHz/T
	127.72 MHz/G

<p><b>QUESTION 35:</b></p> <p><b>The Larmor frequency of hydrogen at field strengths commonly used in clinical MRI sits in which band of the electromagnetic spectrum?</b></p> <p><b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b></p>	
<b>TICK IN THIS COLUMN</b>	
	infrared
	gamma rays
	light
	radiowaves
	microwaves

<b>QUESTION 36 and 37:</b>	
<b>Which TWO (2) of the following are required to produce resonance?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SELECT TWO ANSWERS</b>
	energy at 90 degrees to Bo
	energy at the larmor frequency
	a large flip angle
	heat
	energy in the longitudinal plane

<b>QUESTION 38:</b>	
<b>If a human being was scanned using a 25T magnet, what is the most likely safety issue?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	the scans would be so loud the patient's ear drums would burst
	the patient would be microwaved
	the patient would be exposed to ionising radiation
	the patient would be pulled towards the magnet even if they had no metal inside them or in their clothes
	there are no safety issues

<b>QUESTIONS 39 and 40:</b>	
<b>Which TWO (2) of the following occur as a result of applying an excitation pulse?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SELECT TWO ANSWERS</b>
	magnetic moments of all spins become coherent
	magnetic moments of only the parallel spins become coherent
	magnetization is created in the transverse plane
	magnetization is created in the longitudinal plane only
	spins lose energy and dephase

## SECTION 3

### QUESTION 41 to 60

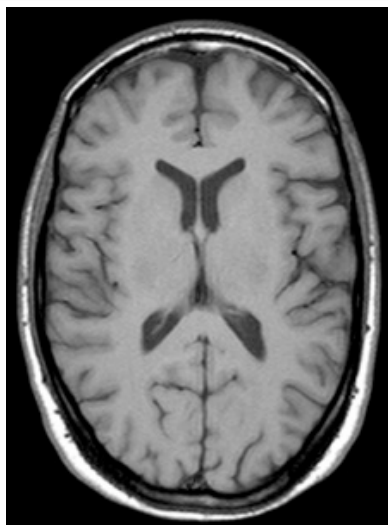
#### IMAGE CONTRAST AND PULSE SEQUENCES

##### QUESTION 41:

What weighting is this image?

TICK IN THIS  
COLUMN

SINGLE ANSWER. SELECT ONLY ONE ANSWER



T2

diffusion

proton density

T1

FLAIR

##### QUESTION 42:

If you were going to use a spin echo sequence to acquire this image at a field strength of 1T, what TR would you use?

TICK IN THIS  
COLUMN

SINGLE ANSWER. SELECT ONLY ONE ANSWER

100 ms

200 ms

400 ms

800 ms

1600 ms



**QUESTION 43:**

**What weighting is this image?**

**TICK IN  
THIS  
COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**



T2

diffusion

proton density

T1

STIR

**QUESTION 44:**

**If you were going to use a spin echo sequence to acquire this image at a field strength of 1T, what TE would you use?**

**TICK IN  
THIS  
COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**

10ms

40 ms

100 ms

1000 ms

1600 ms

<b>QUESTION 45:</b>	
<b>What does the acronym FLAIR mean?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	fast low angle inversion recovery
	fat low attenuation inversion recovery
	fluid attenuation in resonance
	flip angle inversion recovery
	fluid attenuated inversion recovery

<b>QUESTION 46:</b>	
<b>What tissue has the longest T1 and T2 recovery time?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	muscle
	fat
	bone
	collagen
	water
	white matter
cartilage	

<b>QUESTION 47:</b>	
<b>What signal would you expect this tissue to return on a T2 weighted image?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	positive
	hyperintense
	negative
	hypointense
	isointense
isodense	

**QUESTION 48:**

**What pulse sequence is shown below?**

**TICK IN THIS COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**

	inversion recovery
	fast inversion recovery
	gradient echo
	fast or turbo spin echo
	echo planar imaging (EPI)

**QUESTION 49:**

**What extrinsic contrast parameter is unique to this sequence?**

**TICK IN THIS COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**

	T1
	proton density
	flip angle
	Turbo factor or echo train length
	TR
	ADC

**QUESTION 50:**

**What is meant by an intrinsic contrast parameter?**

**write your answer here**

one that cannot be changed by the operator

**QUESTION 51:**

Give an example of an intrinsic contrast parameter?

write your  
answer here

any one of the following: T1 recovery time, T2 decay time, proton density, flow, apparent diffusion coefficient (ADC)

**QUESTION 52:**

What pulse sequence is shown below?

TICK IN THIS  
COLUMN

SINGLE ANSWER. SELECT ONLY ONE ANSWER



inversion recovery

fast inversion recovery

conventional spin echo

gradient echo

driven equilibrium

**QUESTION 53:**

What extrinsic contrast parameter is unique to this sequence?

TICK IN THIS  
COLUMN

SINGLE ANSWER. SELECT ONLY ONE ANSWER

T1

proton density

flip angle

Turbo factor or echo train length

TR

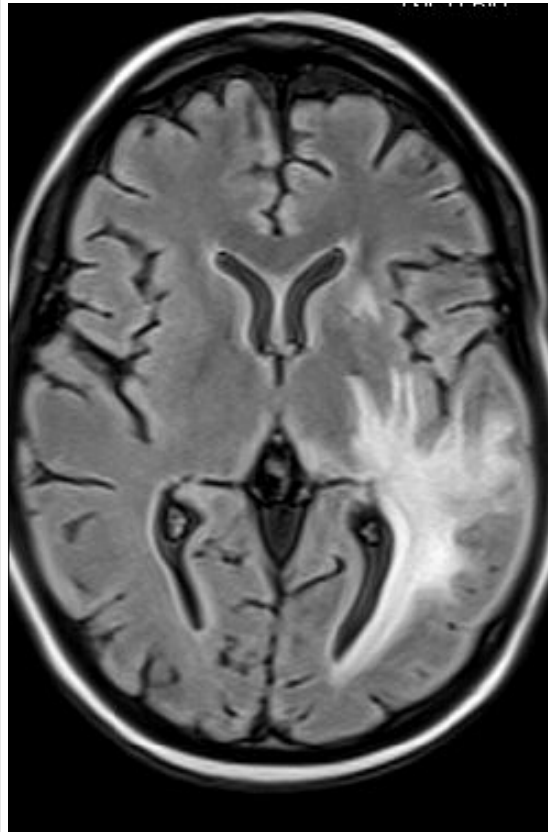
ADC

**QUESTION 54:**

**What sequence was used to produce this image?**

**TICK IN THIS  
COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**



T1

T2

spin echo

STIR

FLAIR

**QUESTION 55:**

**What TI might have been used to produce this image at 1.5T?**

**TICK IN THIS  
COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**

2 ms

20 ms

200 ms

2000 ms

<b>QUESTION 56:</b>	
<b>What tissue is normally suppressed in a STIR sequence?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input type="checkbox"/>	water
<input type="checkbox"/>	muscle
<input checked="" type="checkbox"/>	fat
<input type="checkbox"/>	collagen
<input type="checkbox"/>	normal liver

<b>QUESTION 57:</b>	
<b>Which of the following is true for gradient echo sequences?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input type="checkbox"/>	180 degree RF rephasing of spins
<input type="checkbox"/>	always employs steep gradients
<input checked="" type="checkbox"/>	gradient rephasing of spins
<input type="checkbox"/>	only uses 90 degree flip angles
<input type="checkbox"/>	uses the phase encoding gradient to produce an echo

<b>QUESTION 58:</b>	
<b>What is the most appropriate TI in a STIR sequence at 1.5T?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input type="checkbox"/>	5 ms
<input type="checkbox"/>	50 ms
<input type="checkbox"/>	75 ms
<input checked="" type="checkbox"/>	150 ms
<input type="checkbox"/>	1500 ms

<b>QUESTION 59:</b>	
<b>TICK IN THIS COLUMN</b>	<b>In a turbo or fast spin echo sequence what turbo factor or echo train length is the most appropriate to produce proton density weighted images?</b>
	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	2
	6
	16
	20
	120

<b>QUESTION 60:</b>	
<b>TICK IN THIS COLUMN</b>	<b>What set of parameters below would be the best to use in a T1 weighted gradient echo sequence?</b>
	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
	TR 35 ms / Flip angle 90 degrees/ TE 5 ms
	TR 3500 ms / Flip angle 35 degrees/ TE 5 ms
	TR 35 ms / Flip angle 35 degrees/ TE 15 ms
	TR 35 ms / Flip angle 35 degrees/ TE 15 ms
	TR 35 ms / Flip angle 35 degrees/ TE 5 ms

## SECTION 4

### QUESTION 61 to 80

#### IMAGE PRODUCTION

<b>QUESTION 61:</b> <b>The purpose of spatial encoding is to?</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<b>TICK IN THIS COLUMN</b>	produce an FID
	sample frequencies in the FID
	locate frequencies in three dimensions
	locate inhomogeneities in the field
	shim frequencies in the echo
<b>QUESTION 62:</b> <b>The application of a gradient causes;</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<b>TICK IN THIS COLUMN</b>	linear change in magnetic field strength along an axis of the magnet
	change in precessional frequency of the magnetic moments of spins along the gradient
	change in phase of the magnetic moments of spins along the gradient
	all of the above
<b>QUESTION 63:</b> <b>What physically changes in a gradient coil to alter its amplitude?</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<b>TICK IN THIS COLUMN</b>	direction of the current through the coil
	amount of current through the coil
	resistance in the coil
	temperature of the coil
	thickness of the coil



<b>QUESTION 64:</b>  <b>What physically changes in a gradient coil to alter its polarity ?</b>  <b>TICK IN THIS COLUMN</b>	
<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	direction of the current through the coil
	amount of current through the coil
	resistance in the coil
	temperature of the coil
	thickness of the coil

<b>QUESTION 65:</b>  <b>When is the slice select gradient applied in a conventional spin echo sequence ?</b>  <b>TICK IN THIS COLUMN</b>	
<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	during the excitation pulse
	during the rephasing pulse
	during the echo
	when the phase encoding gradient is applied
	when the excitation and rephasing pulses are applied

<b>QUESTION 66:</b>  <b>What is selected at the console that alters the amplitude of the slice select gradient ?</b>  <b>TICK IN THIS COLUMN</b>	
<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	slice gap
	slice thickness
	number of slices
	phase matrix
	slice matrix

<b>QUESTION 67:</b>  <b>When is the phase encoding gradient applied in a conventional spin echo sequence ?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input type="checkbox"/>	during the excitation pulse
<input type="checkbox"/>	during the rephasing pulse
<input type="checkbox"/>	during the echo
<input checked="" type="checkbox"/>	between the excitation and rephasing pulses
<input type="checkbox"/>	when the excitation and rephasing pulses are applied

<b>QUESTION 68:</b>  <b>What is selected at the console that alters the number of times the phase encoding gradient is applied during the acquisition?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input type="checkbox"/>	phase FOV
<input type="checkbox"/>	slice thickness
<input type="checkbox"/>	frequency matrix
<input checked="" type="checkbox"/>	phase matrix
<input type="checkbox"/>	frequency FOV

<b>QUESTION 69:</b>  <b>When is the frequency encoding gradient applied in a conventional spin echo sequence ?</b>	
<b>TICK IN THIS COLUMN</b>	<b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>
<input type="checkbox"/>	during the excitation pulse
<input type="checkbox"/>	during the rephasing pulse
<input checked="" type="checkbox"/>	during the echo
<input type="checkbox"/>	between the excitation and rephasing pulses
<input type="checkbox"/>	when the excitation and rephasing pulses are applied

<b>QUESTION 70:</b>  <b>What is selected at the console that alters the amplitude of the frequency encoding gradient ?</b>  <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	phase FOV
	slice thickness
	frequency matrix
	phase matrix
	frequency FOV

<b>QUESTION 71:</b>  <b>What is does the NSA/NEX/Naq parameter alter??</b>  <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	amplitude of the echo
	number of data points in each line of K space
	number of lines in K space
	the number of times a line of K space is filled with data
	number of data points in each column of K space

<b>QUESTION 72:</b>  <b>The frequency matrix determines which of the following?</b>  <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
	amplitude of the echo
	number of data points in each line of K space
	number of data points in each column of K space
	number of lines in K space
	the number of times a line of K space is filled with data

<p><b>QUESTIONS 73 and 74:</b></p> <p><b>Reducing the receive bandwidth alters which TWO (2) of the following?</b></p> <p><b>TICK IN THIS COLUMN</b>      <b>SELECT TWO ANSWERS</b></p>	
	digital sampling frequency
	NSA/NEX/Naq
	sampling time
	slice number
	phase matrix


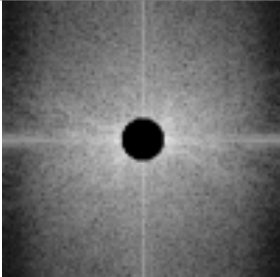
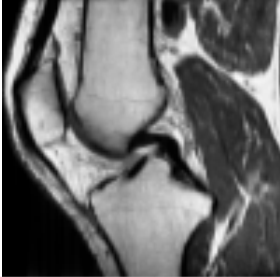
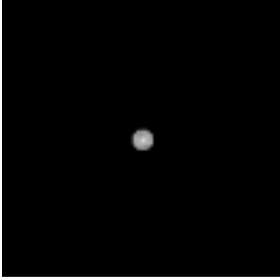
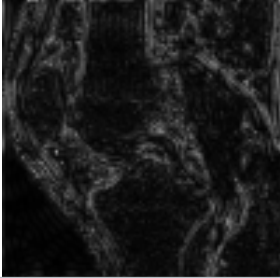
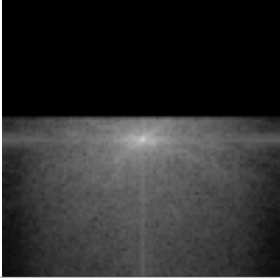
<p><b>QUESTION 75:</b></p> <p><b>In a closed bore super-conducting system, the Z gradient selects slices in which plane?</b></p> <p><b>TICK IN THIS COLUMN</b>      <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b></p>	
	sagittal
	axial
	coronal

<p><b>QUESTIONS 76 and 77:</b></p> <p><b>Which of the following TWO (2) statements true about the phase encoding gradient</b></p> <p><b>TICK IN THIS COLUMN</b>      <b>SELECT TWO ANSWERS</b></p>	
	the maximum amplitude determines the phase FOV dimension
	its amplitude changes throughout the sequence
	its polarity changes to fill the top and bottom lines of K space
	it is switched on during excitation
	it always encodes signal along the X axis of the magnet

**QUESTIONS 78, 79 and 80:**

The three images on the left (A, B and C) were reconstructed from the K space data shown on the right (1,2 and 3). Which K space area relates to which image?

WRITE THREE ANSWERS IN THE BOXES BELOW

<b>A</b>		<b>1</b>	
<b>B</b>		<b>2</b>	
<b>C</b>		<b>3</b>	
<b>A relates to</b>	2		
<b>B relates to</b>	3		
<b>C relates to</b>	1		

**SECTION 5**  
**QUESTIONS 81 to 100**

**IMAGE OPTIMIZATION**

**QUESTIONS 81,82, 83,and 84:**

**List FOUR (4) consequences of reducing the TR below 2000ms in a conventional spin echo pulse sequence**

**WRITE FOUR ANSWERS IN THE BOXES BELOW**

- |          |                           |
|----------|---------------------------|
| <b>1</b> | reduction in scan time    |
| <b>2</b> | reduction in slice number |
| <b>3</b> | increased T1 weighting    |
| <b>4</b> | reduced SNR               |

**QUESTION 85:**

**What is this artifact?**



**write your  
answer here**

aliasing (also accept phase wrap or fold over)

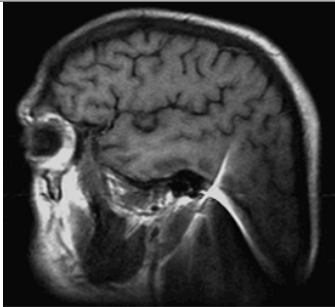
<b>QUESTION 86:</b> <b>This artifact could be removed by increasing which of the following?</b> <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<input type="checkbox"/>	scan time
<input type="checkbox"/>	phase encoding gradient
<input checked="" type="checkbox"/>	phase FOV
<input type="checkbox"/>	phase matrix
<input type="checkbox"/>	flip angle

<b>QUESTION 87:</b> <b>An out of phase image can aid diagnostic value in which of the following circumstances?</b> <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<input type="checkbox"/>	when there is movement
<input type="checkbox"/>	for quantifying flow
<input type="checkbox"/>	for improving SNR
<input checked="" type="checkbox"/>	there is a lesion that contains fat and water
<input type="checkbox"/>	for demonstrating hemorrhage

<b>QUESTION 88:</b> <b>Gradient moment nulling or flow compensation is used to correct an artefact caused by which of the following?</b> <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<input checked="" type="checkbox"/>	slow laminar flow
<input type="checkbox"/>	time of flight effect
<input type="checkbox"/>	turbulent flow
<input type="checkbox"/>	breathing
<input type="checkbox"/>	high speed vortex flow

<p><b>QUESTION 89:</b></p> <p><b>If the NSA/NEX/Naq is doubled what effect does this have on the SNR?</b></p> <p><b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b></p>	
	increase by a factor of 1.2
	decrease by a factor of 1.2
	increase by a factor of 1.4
	decrease by a factor of 1.4
	increase by a factor of 2.0

<p><b>QUESTION 90:</b></p> <p><b>If the NSA/NEX/Naq is doubled what effect does this have on the scan time?</b></p> <p><b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b></p>	
	increase by a factor of 1.2
	decrease by a factor of 1.2
	increase by a factor of 1.4
	increase by a factor of 2.0
	increase by a factor of 4.0

<p><b>QUESTION 91:</b></p> <p><b>What is this artefact?</b></p>	
	
<b>write your answer here</b>	magnetic susceptibility or metal artefact



<b>QUESTION 92:</b> <b>What pulse sequence is most likely to reduce the artefact shown in question 91?</b> <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<input type="checkbox"/>	gradient echo
<input type="checkbox"/>	spin echo
<input type="checkbox"/>	inversion recovery
<input type="checkbox"/>	STIR
<input checked="" type="checkbox"/>	single shot turbo or fast spin echo

<b>QUESTION 93:</b> <b>What pulse sequence is most likely to increase the artefact shown in question 91?</b> <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<input checked="" type="checkbox"/>	gradient echo
<input type="checkbox"/>	spin echo
<input type="checkbox"/>	inversion recovery
<input type="checkbox"/>	STIR
<input type="checkbox"/>	single shot turbo or fast spin echo

<b>QUESTION 94:</b> <b>The artefact shown in question 91 may increase the conspicuity of which pathology?</b> <b>TICK IN THIS COLUMN</b> <b>SINGLE ANSWER. SELECT ONLY ONE ANSWER</b>	
<input type="checkbox"/>	marrow infiltration of tumor
<input type="checkbox"/>	adenoma
<input checked="" type="checkbox"/>	hemorrhage
<input type="checkbox"/>	infection
<input type="checkbox"/>	infarction

**QUESTIONS 95,96, 97,and 98:**

**List FOUR (4) consequences of reducing the phase matrix**

**WRITE FOUR ANSWERS IN THE BOXES BELOW**

<b>1</b>	reduction in scan time
<b>2</b>	reduction of phase resolution
<b>3</b>	increase in SNR
<b>4</b>	increase in likelihood of truncation artefact

**QUESTION 99:**

**Which of the following strategies would double the SNR?**

**TICK IN THIS  
COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**

	doubling the FOV
	doubling the phase matrix
	doubling the slice thickness
	doubling the TE

**QUESTION 100:**

**Increasing the receive bandwidth results in which of the following?**

**TICK IN THIS  
COLUMN**

**SINGLE ANSWER. SELECT ONLY ONE ANSWER**

	increases SNR, decreases minimum TE
	decreases SNR, increases minimum TE
	increases SNR, increases minimum TE
	decreases SNR, decreases minimum TE
	does not affect SNR or minimum TE
	increases SNR, minimum TE unchanged
	decreases SNR, minimum TE unchanged

**END OF QUIZ**

**THANK YOU FOR TAKING PART**

## APPENDIX 5a: OSCE scores – graduate practitioners

GRADUATE	Years experience	Graduate ID	Section 1 correct	Section 1 DNA	Section 1 incorrect	Section 2 correct	Section 2 total DNA	Section 2 incorrect	Section 3 correct	Section 3 DNA	Section 3 incorrect	Section 4 correct	Section 4 DNA	Section 4 Incorrect	Section 5 correct	Section 5 DNA	Section 5 incorrect		Total	Total DNA	Total Incorrect
	0	1	12	0	8	15	1	4	15	3	2	9	2	9	6	8	6		57	14	29
	1	3	12	5	3	9	8	3	13	3	4	7	5	8	9	8	3		50	29	21
	3	5	14	0	6	16	0	4	15	0	5	14	0	6	13	0	7		72	0	28
	1	7	15	1	4	15	4	1	11	3	6	4	5	11	12	2	6		57	15	28
	4	9	17	0	3	17	0	3	16	0	4	19	0	1	16	0	4		85	0	15
	3	15	14	1	5	14	3	3	8	9	3	8	5	7	6	6	8		50	24	26
	3	21	18	0	2	17	0	3	15	3	2	14	1	5	16	1	3		80	5	15
	6	23	16	1	3	13	1	6	10	2	8	4	2	14	8	4	8		51	10	39
	5	27	15	1	4	9	7	4	10	9	1	7	9	4	12	4	4		53	30	17
	7	29	14	1	5	10	0	10	15	0	5	11	4	5	8	3	9		58	8	34
	0.5	33	17	0	3	14	0	6	16	1	3	15	0	5	12	3	5		74	4	22
	3	35	12	1	7	13	0	7	14	1	5	5	0	15	9	0	11		53	2	45
	2	45	16	2	2	9	5	6	11	2	7	10	0	10	9	4	7		55	13	32
	1	49	14	5	1	12	6	2	10	5	5	8	8	4	4	11	5		48	35	17
	1	53	17	2	1	14	2	4	16	2	2	18	0	2	10	5	5		75	11	14
	1.5	61	15	2	3	16	1	3	15	2	3	13	0	7	14	3	3		73	8	19
	8	63	13	0	7	10	0	10	13	0	7	14	0	6	12	1	7		62	1	37
	16	67	17	1	2	15	0	5	16	0	4	15	0	5	14	0	6		77	1	22
	1	69	10	1	9	12	0	8	12	0	8	6	0	14	7	0	13		47	1	52
	0.5	71	16	2	2	14	4	2	16	1	3	10	3	7	7	8	5		63	18	19
	0.5	79	17	1	2	15	0	5	14	0	6	13	0	7	12	3	5		71	4	25
	0	83	14	3	3	15	2	3	17	0	3	12	4	4	11	2	7		69	11	20
	1	87	13	3	4	16	1	3	11	3	6	12	2	6	9	6	5		61	15	24
	6	97	16	0	4	16	0	4	16	0	4	12	0	8	10	1	9		70	1	29
	4	99	17	0	3	13	0	7	11	0	9	16	0	4	11	0	9		68	0	32
Total	79	Total	371	33	96	339	45	116	336	49	115	276	50	174	257	83	160		1579	260	661
Mean	6.08																	TOTAL			
		Mean	14.84	1.32	3.84	13.56	1.8	4.64	13.44	1.96	4.6	11.04	2.00	6.96	10.28	3.32	6.4	Mean	63.16	10.4	26.44
		Standard D	2.06	1.44	2.13	2.52	2.5	2.4	2.55	2.54	2.12	4.20	2.69	3.59	3.10	3.09	2.50	Standard D	11.03	10.23	9.64
		Minimum	10	0	1	9	0	1	8	0	1	4	0	1	4	0	3	Minimum	47	0	7
		Maximum	18	5	8	17	8	10	17	9	8	19	9	15	16	11	13	Maximum	85	35	52
		Variance	4.22	2.06	4.56	6.34	6.08	5.57	6.51	6.46	4.50	17.62	7.25	12.87	9.63	9.56	6.25	Variance	121.56	104.67	92.84

## APPENDIX 5b: OSCE scores – experiential practitioners

EXPERIENTIAL	Years experience	Experiential ID	Section 1 correct	Section 1 DNA	Section 1 incorrect	Section 2 correct	Section 2 DNA	Section 2 incorrect	Section 3 correct	Section 3 DNA	Section 3 incorrect	Section 4 correct	Section 4 DNA	Section 4 incorrect	Section 5 correct	Section 5 DNA	Section 5 incorrect		Total Correct	Total DNA	Total Incorrect
	5	4	14	0	6	9	0	11	11	0	9	9	0	11	6	4	10		49	4	47
	8	6	9	3	8	13	0	7	6	5	9	8	0	12	6	5	9		42	13	45
	11	10	15	1	4	13	3	4	15	2	3	11	1	8	15	2	3		69	9	22
	15	14	15	0	5	14	0	6	11	0	9	12	0	8	11	1	8		63	1	36
	9	16	10	3	7	10	1	9	4	6	10	5	3	12	4	5	11		33	18	49
	20	18	16	0	4	10	2	8	11	1	8	7	5	8	9	4	7		53	14	35
	5	20	12	1	7	9	0	11	7	2	11	5	0	15	6	2	12		39	5	56
	16	22	14	0	6	12	2	6	12	0	8	12	1	7	6	6	8		56	9	35
	9	30	12	2	6	5	6	9	6	7	7	4	11	5	7	5	8		34	31	35
	15	32	19	0	1	10	3	7	13	2	5	9	0	11	6	3	11		57	8	35
	20	38	11	0	9	7	4	9	11	2	7	8	3	9	7	7	6		44	16	40
	1.5	40	11	2	7	7	11	2	6	7	7	4	12	4	4	12	4		32	44	24
	4	42	14	2	4	16	1	3	15	1	4	10	2	8	11	3	6		66	9	25
	10	44	14	4	2	8	3	9	16	2	2	9	0	11	14	1	5		61	10	29
	3	56	6	9	5	6	9	5	4	16	0	0	16	4	2	15	3		18	65	17
	23	60	16	0	4	7	2	11	10	2	8	10	2	8	11	5	4		54	11	35
	29	64	17	0	3	17	0	3	19	0	1	14	0	6	16	0	4		83	0	17
	18	72	13	1	6	11	1	8	17	0	3	8	2	10	8	1	11		57	5	38
	4	74	14	0	6	10	0	10	10	2	8	8	3	9	9	3	8		51	8	41
	8	76	17	0	3	13	0	7	10	1	9	6	5	9	8	3	9		54	9	37
	30	88	17	0	3	14	0	6	14	2	4	11	1	8	12	2	6		68	5	27
	9	94	15	1	4	12	0	8	12	0	8	13	0	7	8	0	12		60	1	39
	27	100	18	0	2	14	0	6	20	0	0	17	0	3	18	0	2		87	0	13
Total	299.5	Total	319	29	112	247	48	165	260	60	140	200	67	193	204	89	167		1230	293	777
Mean	13.02																	TOTAL			
		Mean	13.87	1.26	4.87	10.74	2.09	7.17	11.30	2.61	6.09	8.70	2.91	8.39	8.87	3.87	7.26	Mean	53.48	12.83	33.78
		Standard D	3.09	2.07	2.05	3.24	2.98	2.61	4.49	3.65	3.30	3.76	4.36	2.89	4.08	3.65	3.08	Standard D	16.24	15.15	10.79
		Minimum	6	0	1	5	0	2	4	0	0	0	0	3	2	0	2	Minimum	18	0	8
		Maximum	19	9	9	17	11	11	20	16	11	17	16	12	18	15	12	Maximum	87	65	56
		Variance	9.57	4.29	4.21	10.47	8.90	6.79	20.13	13.34	10.90	14.13	18.99	8.34	16.66	13.30	9.47	Variance	263.7	229.51	116.36
		Total Score Both Groups	Section 1 correct	Section 1 DNA	Section 1 Incorrect	Section 2 correct	Section 2 DNA	Section 2 incorrect	Section 3 correct	Section 3 DNA	Section 3 incorrect	Section 4 correct	Section 4 DNA	Section 4 Incorrect	Section 5 correct	Section 5 DNA	Section 5 incorrect				
			690	62	208	586	93	281	596	109	255	476	117	367	461	172	327				

## APPENDIX 6: Interview question template

### Clinical Manager USA

What is your role in this department?  
What type of imaging takes place in this department?  
What type of MRI practitioners are employed here?  
Are you an MRI Practitioner and if so what qualifications do you have?  
What are your views on the standard of education of MRI practitioners that you employ?  
What is your understanding of the term “specialism” in the imaging professions?  
Are there any differences between specialising in a modality that is not learnt at undergraduate level compared to one that is and if so what are they?  
How do graduate practitioners fit into the organisation?  
How are graduate practitioners treated by other types of practitioners and radiologists?  
How do graduate practitioners professional values vary from other types of MRI practitioner?  
What attitudes do other professionals have towards graduate practitioners compared to other types of MRI Practitioners?  
Can you provide some examples of differences in the levels of competency and knowledge between graduate practitioners and other MRI practitioners?  
Are there problems in deploying graduate practitioners on the rota due to the fact that their area of practice is limited? Can you provide any examples?  
What are the differences in attitudes towards continuing professional development between graduate practitioners and other types of MRI practitioner? Can you give some examples where you have noticed this?  
Overall how supportive are you of non-radiographers entering MRI practice without a general radiographic background and can you give your reasons for this?

### Clinical Manager UK

What is your role in this department?  
What type of imaging takes place in this department?  
What type of MRI practitioners are employed here?  
Are you an MRI Practitioner and if so what qualifications do you have?  
What are your views on the standard of education of MRI practitioners that you employ?  
What is your understanding of the term “specialism” in the imaging professions?  
If direct-entry into MRI via a specialised degree was introduced in the UK and the curriculum included topics such as anatomy, patient care and professional values, how supportive are you of non-radiographers entering MRI practice without a general radiographic background?

What do you see might be the benefits of employing someone who has undertaken a dedicated degree in MRI?

What do you see might be the drawbacks of employing someone who has undertaken a dedicated degree in MRI but is not a radiographer?

In terms of competency and knowledge to practice how important is it for an MRI practitioner to also be a qualified radiographer?

What impact do you think that the introduction of direct-entry into MRI via a specialised degree might have on CPD?

How important is it for an MRI practitioner to be registered with the HCPC in terms of employing them in your department?

### Graduate Practitioners

What qualifications do you hold?

Give two examples of what you enjoyed about the specialised MRI programme you completed at this University.

Give some examples of what could be improved.

What type of examinations do you undertake without supervision?

What are your responsibilities?

Can you provide any examples of problems that have arisen because your area of practice is limited?

Are you concerned that not being a radiographer will limit your employability? Have you had an experience of this?

Do you feel that you are respected by other types of practitioners and radiologists in your department?

What are your professional values and to what extent do you believe you adhere to these in your practice?

How confident are you in undertaking MRI examinations?

How would you rate your level of knowledge in MRI?

What is your understanding of the term "specialism" in the imaging professions?

Are there any differences between specialising in a modality that is not learnt at undergraduate level compared to one that is? If so what are they?

What are your aspirations in terms of CPD?

From what you have observed and experienced yourself, what are your views on the standard of education of MRI practitioners as a whole?

Overall how supportive are you of non radiographers entering MRI practice without a general radiographic background and can you give your reasons for this?

### Experiential Practitioners

What sort of education have you had in the past both generally and in MRI?

What qualifications do you hold?

How long have you been practicing as an MRI practitioner?

What type of examinations do you undertake without supervision?

How do you fit into this organisation and what are your responsibilities?

How often are you expected to perform examinations other than MRI?

How important is it to you to have a general radiographic qualification in terms of employability? Have you had an experience where this has been necessary to fulfil your role?

How are you treated by other types of practitioners and radiologists in your department?

What is your understanding of professional values and to what extent do you believe you adhere to these in your practice?

How knowledgeable do you think you are and how does this compare to other types of MRI practitioners who have learnt MRI differently to you?

What is your understanding of the term “specialism” in the imaging professions?

Are there any differences between specialising in a modality that is not learnt at undergraduate level compared to one that is? If so what are they?

What are your aspirations in terms of CPD?

From what you have observed and experienced yourself, what are your views on the standard of education of MRI practitioners as a whole?

Overall how supportive are you of non radiographers entering MRI practice without a general radiographic background and can you give your reasons for this?

## Academic USA

What is your role in the MRI programme at this University?

Were you involved in setting up this programme and if so what were your motivations for doing so?

How popular is this programme to non-radiographers and how easy is it to recruit them?

Approximately how many students do you recruit with a radiographic background compared to those that don't?

What are your selection criteria and do they include previous radiographic experience?

How important is it that the student has previously attained a degree in diagnostic Radiography?

Are there any differences in how they perform in the clinical environment?

Can you give some examples?

What are the professional barriers to MRI practitioners not being radiographers first?

What percentage of your students get a job in MRI after graduating? Is there a difference between non radiographers and radiographers in this regard?

Are you aware of any registration or employment problems for non radiographers graduating from your University?

What is your understanding of the term “specialism” in the imaging professions?

Are there any differences between specialising in a modality that is not learnt at undergraduate level compared to one that is?



How does the teaching of MRI compare between this specialised programme and in a general radiographic programme?  
Overall how supportive are you of non radiographers entering MRI practice without a general radiographic background and can you give your reasons for this?

### Society and College of Radiographers Professional Representative

What is your role in this organisation?  
What is your understanding of the term “specialism” in the imaging professions?  
If direct-entry into MRI via a specialised degree was introduced in the UK and the curriculum included topics such as anatomy, patient care and professional values, how supportive are you of non-radiographers entering MRI practice without a general radiographic background?  
What do you see might be the benefits of direct-entry into MRI via a specialised degree in MRI?  
What do you see might be the drawbacks of direct-entry into MRI via a specialised degree in MRI?  
What impact do you think the introduction of a direct-entry into MRI would have on the radiographic profession as a whole?  
What impact do you think that the introduction of direct-entry into MRI via a specialised degree might have on CPD?  
How important is it for an MRI practitioner to be registered with the HCPC?  
In Australia, a separate registration body was set up by monographers so that those entering the profession directly via a specialised degree in ultrasound could benefit from registration. How supportive would you be of a similar body for MRI practitioners in the UK if it was not possible to secure this via the HCPC? Can you give reasons for this?

## APPENDIX 7: Interview transcripts

TRANSCRIPT: CMUSA.

(I) = INTERVIEWER.

(P) = PARTICIPANT.

(I) (I) now it's going, I'll just put it there... I've got both things just in case it fails, you never know. So, first of all can I just ask you what your role is in this department?

(P) I'm the director of imaging services.

(I) ok and are you responsible for sort of hiring and firing people?

(P) I am.

(I) ok and what sort of... in fact Patrick would have answered this, you have a whole gamut of different types of imaging in this department from ultrasound, nuclear medicine, PET. Do you have all of that?

(P) yes.

(I) ok. So, what type of MRI practitioners are employed here? I mean, how many are primary and how many are post-primary?

(P) the majority of the staff and Patrick probably gave you better data are RT's. We are moving towards hiring those that are MR trained only and we have quite a few of those because number one it's less costly to hire somebody that's MRI trained. There are certain benefits and disadvantages to that...

(I) ok we'll probably be getting on to that but that's interesting you've raised that actually because I will be sort of asking that a bit later but so, you're mainly RT's but you're coming through now with employing MR only people and is that because you're sort of involved with the programme here or is that just... I mean...

(P) it's a little bit of both ok? We're very much supportive of the programme because it is RT's, MR, ultrasound and other students come through, through our department so we have a look at them and we can assess who will be the best fit for the department and skill level of personality and all those kinds of things. So, have I answered your question?

(I) yes, I think so and you are taking on more MR only people?

(P) yes.

(I) and is that because... I mean, you've mentioned the finance but is it also that they are a better fit for your department or...?

(P) it is highly dependent on the individual...

(I) ok right, yes...

(P) some are wonderful, come in, hit the ground running and it's perfect. Others it takes a considerable length of time to train them, to help them understand the culture of the organisation and what our expectations are a little bit more.

(I) is that because there... is that anything to do with they're background or what you know, educationally or what they've studied for?

(P) a lot of times, yes or what they're previous jobs have been... do you want to address one specifically more than the others?

(I) yes, I mean are there... I mean, so what sort of jobs coming in would they be better at it than...?

(P) ok, in RT obviously ok has the clinical background. If a patient... and I will share some experiences with you. We had a gentleman asked for a urinal. Ok, MR only trained Tech, couldn't accomplish the task an RT knows how to do that and if somebody needs to vomit, an RT can handle that. A lot of times, the MR only student has not had the clinical experience to do that ok and again, that depends on the individual. So, if they served in a capacity somewhere as an aid for example, ok then they have that. Another experience I had was with an MRI student who was helping a patient to the bathroom and if the bathroom is here, the person put the wheelchair here and required that the patient walk all the way around the wheelchair into the bathroom and an RT would put the wheelchair here! Just simple common sense kinds of things that aren't always present.

(I) ok and are you comparing... when you say are these students undergoing the programme or are these people who have graduated?

(P) students undergoing training.

(I) because you might expect that behaviour from an RT student?

(P) any student...

(I) any student... it's not necessarily that one is an RT, it's because Patrick raised the same thing you know, that experience is nothing to do with the programme, it's just they don't have the experience. If you took a student RT and a student MR person, they probably would do equally stupid things because if they've both got two years clinical experience post-qualification, they'd probably be you know... so it's not the programme...

(P) not as such, it's the experience, you are correct.

(I) so, the non RT people that are coming through the MR programme, if they have a background in something to do with like you say an aid or something...

(P) or any service...

(I) whereas, if they come in from I don't know retail or something...

(P) Or having had nothing, you know?

(I) nothing at all. Yes, it mean that makes sense really that it isn't the fault of the programme necessarily,

(II) (P) no its not..

(III) So, in just sort of thinking about the people you employ, you know MR practitioners is what I'm calling them, what generally do you think about their standard of education and their knowledge when they come to you for the first time? I mean, is it generally good, bad?

(P) very specifically from the programme or...?

(I) no, anywhere really, just generally what are your thoughts about you know, MRI education? The people who come in and work for you irrespective of how they've learnt it?

(P) naturally, I'm going to answer your question the way you want it so please fix me if I'm not...

(I) no, just answer it honestly, it's not the way I necessarily wanted it because I don't have a way necessarily.

(P) again, it's totally dependent on the individual, the individual's work ethic and how much they put out as opposed to... their personalities, their compassion, that's what I'm looking for. We can keep training anybody to press a button...

(I) ok but it's everything else?

(P) right, ok that's probably the first thing I look for. Secondly, we don't want them to just be button pushers. We want them to understand things phase and frequency, when to adjust an image if I have an artefact. How to decrease the time it takes to produce an image if I have a patient who is struggling. Ok, those are the things that I would really like to see.

(I) and how often do you see that generally?

(P) Probably... 75 to 80 percent of the time, when they're brand new.

(I) when they're brand new and is this... is there a difference in that kind of knowledge between somebody who's been a Tech who hasn't been through a programme versus someone who has come through the programme?

(P) no.

(I) no difference?

(P) Its just... I mean, let's face it, MR physics is not easy...

(I) no, no, no...

(P) it's not. So, it's very difficult for either someone who is brand new to the programme or brand new across training as an RT. Ok because that's what we'd do, it would be a programme graduate or someone that we're cross training and that has its advantages and disadvantages too cross training because that person is as smart than the person who's training them, who has the transfer of knowledge.

(I) yes, so I think this is a sort of a common thing that there is a big variation as I've said in the standard of what people can actually do and it is the protocol modification side of things that I think it comes out as to how educated somebody is in MR theory and that kind of thing. So, I mean basically, you are saying but it is again down to the individual and that it is variable?

(P) yes.

(I) yes, ok. So, what proportion of new employees need extra training in MR when you first employ them?

(P) ... if they've gone through our programme, we usually give them a three to six month orientation and help them understand a little bit more of the culture of the expectations, those kinds of things and the nuances, the stuff we talked about. You know, if this happens how do you fix it?

(I) ok. So that would be the primary pathway people if you employed them, they'd need...? How about an MR, a Tech that you bring in, an RT from somewhere?

(P) I'd say about a year, we give them about a year.

(I) so, it's longer then are you saying?

(P) yes.

(I) ok, well that's... so there is a benefit there to you I would think in terms of the amount of training they need?

(P) yes.

(I) ok, you know that the programme is giving the training is less?

(P) yes.

(I) ok and so the training that you give them, what form does it take? You say it's orientation and...?

(P) to either...

(I) to either of them really or you know, tell me for both what sort of training would you give?

(P) so for the RT, we would be very specific who we chose. It would be the individual a person then they can deal with it, we've talked about the compassionate you know, that has those people skills that we need. Then, we would assign them, in this case it would be Patrick, ok here's what we need, you know I understand the physics, I understand about technology, I understand, you know I'll go through your book...

(I) so they just get the full sort of MR training don't they because they don't have it properly, yeah ok.

(P) and you know, helping with MR physics and you know, those kinds of concepts which are totally new to them.

(I) and the people who've gone through the programme that are not TEC's who need this three to six month... what sort of training do they need?

(P) I think just to sharpen their ability to make those quick on the fly changes, phase frequency, those kind of things.

(I) so they already know it but it's just refining it?

(P) right, right...

(I) ok yes, that would make sense really, you know certainly it would wouldn't it, if they've already had the training anyway. Ok, now the next set of questions I'm asking everybody, ok because I'm interviewing all kinds of different people who will have a stake in this whole issue. Now, this is about what specialism means in imaging you know because as part of my literature review, there's a hugely different... people define specialist different. They define specialist practice differently and so, I'm asking everybody because I want to get their take specifically on that because it has relevance. So, the first question is we use the term specialist imaging modality in Radiography. What would you consider as the specialist imaging modality is in this department?

(P) ... CT, ultrasound, NUC, PET CT, IR, intervention radiology...

(I) yeah and MRI would you consider MR?

(P) yes.

(I) so everything that's not sort of the diagnostic Radiography?

(P) yes.

(I) ok. Do you think that specialism in Radiography is related to working in one of those modalities or is it just to do with the amount of responsibility that someone has. So would... if somebody had a tech who works in MR, would you say they are a specialist over somebody who does bariums but is really brilliant at them?

(P) in the terminology of this department?

(I) so in your opinion really. I mean, a lot of these people haven't actually thought about it you know, it's in your opinion if you were... yes, when you sort of think about your employees do you think about the people in work in these modalities as being more advanced practitioners than somebody who's doing the generalist stuff but really at a high level?

(P) yeah. I think not necessarily at a higher level but they have acquired an additional skill and that's what makes them higher because you consider like the technologists who are surgically trained, who are excellent at trauma, those kinds of things makes them very good in their practice.

(I) right yes. So, if with somebody who'd done the programme here who isn't a tech, they haven't learnt an additional skill, they've just learnt something different. Would you consider them less of a specialist then than somebody who's a Tech and has got all these additional skill in MR?

(P) I would consider them less of a specialist only because I can't move them from modality to modality.

(I) right ok because that's interesting because you see that would... being able to move somebody means that they are a generalist sort of person. What I'm sort of getting at here is this is words that other researchers have banded about is are we looking at something that's different when you do MR, is it just different knowledge or is it more superior knowledge or more advanced. You know, is it advancement of prior knowledge because that makes a big difference in how you would educate somebody. The level of curriculum that you put in, depending on what you're trying to do?

(P) ok, I think it's different knowledge as opposed to advanced knowledge. If you start out as an RT and you have additional knowledge, then I would consider it advanced. In fact, if I start out as an RT and I get the additional knowledge, then I've advanced my career, right and as we're having this conversation I'm thinking you're making me think because an MR student or an MR... a new MR graduate from a programme will make more than a new RT graduate which I find very interesting based on this conversation.

(I) oh it is isn't it you know because if you take ultrasound, you know there's a lot of parallels you see. I mean, ultrasound is a completely different modality to x-rays, it doesn't involve ionising radiation, it's a completely different profession. So, Bachelor's specifically in ultrasound are coming through now in lots of countries, in the UK, in Australia and here, you don't... there's no problem with that. Now, in MRI it's a completely different profession using non-ionising radiation, so you know why should it be seen as something that's more special, you know. I think the terminology is something that perhaps people haven't thought about because historically you know, you do your Radiography and yes, you advance into these other areas but you know, I'm putting it out there that actually it's not advanced, it's just different. Is it you know? If ultrasound's different and why should somebody get paid differently, you know? That's another sort of tier of things ....but that's interesting that you've said that. You're essentially saying it is different really aren't you I think? So, what benefits do you as a manager and the department therefore of employing someone who has just done this course, this programme in MRI and they're not a tech?

(P) the cost of training...

(I) ok because it takes a shorter period of time to train.

(P) well, if I hired somebody from... if I put an RT into the department, ok there would be a much larger cost and it would take someone... I'm paying for the tech to... the student to learn MR. I'm pulling in someone from staffing to teach, I mean it coincides with their work but there still is a split focus ok? The time to utilise those team members, when can they work alone, when can they take call when they can work weekends, you know when can they cover vacation on their own and everything, the reliability there and I say three to six months or you know, a year for an RT but that's going to vary very much based on the individuals performance because you can take an x-ray tech who is outstanding and put him in an environment and they'll be clueless for an extended period of time if they don't get the physics.

(I) and that's... I can... that is a very individual thing and I suppose you can only comment sort of generally I suppose. Do you pay them differently? I mean, if you were to take you know, one from each group, let's you know, do they end up having the same salary or is the primary pathway person paid less?

(P) actually they paid more.

(I) their paid more? Ok and what's the thinking behind that?

(P) well because they are already registered...

(I) with the boards you mean?

(P) yes.

(P) ok...

(P) ok. We were... prior to new regulations, we would hire a student graduate who was not registered. Ok, we have now regulations that if we want to be accredited, all of staff need to be registered or certified with the board, ok? So, if we do not hire anybody that's not registered and because their registered, they would get paid more than the RT coming across. Once the RT finishes our individualised training and registered, then they will also be bumped up.

(I) so they end up after the registration process getting paid the same?  
(P) yes.  
(I) ok. So, it's the registration issue and the programme prepares them specifically for the boards doesn't it?  
(P) yes.  
(I) that makes sense. So, ok now we're going to look at the drawbacks ok of employing someone who can only do an MRI scan. Are there problems with that in terms of the roster here?  
(P) not at this point and not in this size of an institution. Where I worked previously, we did both MR and CT ok? Having said that, you need to be an RT to do CT and nobody else out of healthcare is going to understand RT, CT. So, I think it is advantageous to me as a manager to be able to move somebody around if I need to, ok and I think more and more we're going to find that to be the case that we need to be able to employ associates who can do several things.  
(I) why is that and what...?  
(P) well, cost is going to be a big thing ok and if our volumes decline then our staffing is going to decline also and that team members will be more valuable to me and actually to themselves if they can do multiple things, ok. in one of our smaller hospitals, ok we have staff that does ultrasound, x-ray and CT, ok and we can move them around as we need to. They are limited in what they can do if it's an ultrasound person, they are limited to what they can do and CT being we don't want them to... jack of all trades, master of none, we don't want to go there. So, they are limited to what exams they can do but they can cover call in ultrasound and they can cover call in CT and we need one person to do that now.  
(I) so yes that was going to be my next question. I mean, obviously if you're a generalist person you can't necessarily do all of those things to the highest level but it's enough from a practical, logistical point of view they can do the key things?  
(P) yes.  
(I) yeah ok and I mean, you employ both types of person here, how do the doctors view them? Do they view them differently? Is there sort of any division that you can see?  
(P) I haven't heard any real complaints that lead me to wonder one direction or the other..Again, it's based on the individual rather than you know, the programme.  
(I) yes, so you don't... the tech's do they treat the primary pathway people sort of look down on them or treat them differently?  
(P) I think they did at the outset but that's changing.  
(I) ok yes because I think there's some protectionism goes on I think you know, which is understandable but if people are coming through who are good at the job then I guess... yeah ok...  
(P) I think it got to a point where they had to prove themselves and we've passed that now.  
(I) yes ok and do you think people who stay focused just on MRI, do you think they have better job satisfaction or stay in the job longer than if they're being asked to do things they don't really want to do?  
(P) again, I think that depends on the individual. I think that everybody is different and I use that based on my own experience. When you do MR repeatedly and all you do let's say lumbars all day and your sitting there waiting for you know, four minutes for a sequence to pass, you kind of get bored with doing the same thing. I mean, to be frank...  
(I) yeah so it doesn't matter...?  
(P) ... but if you're doing CT, it's the same thing. So, for me it was good to have the variations.  
(I) yes, whereas I guess for somebody like Patrick who really loves MR you know, he gets his variation in teaching and that kind of thing, so I can see that's... and yes, the other thing is you know, about the limited practice of somebody who can only do MRI? Do you anticipate they might have trouble finding employment or not?  
(P) I don't think so, no.  
(I) no. I mean, I don't know quite... I was talking to Kerry about this in the car and you know, about whether the graduates are getting employment or not but it's not to do with that, it's just where there's availability of jobs I think, ok. So, in terms of competency and knowledge to practice, how important is it do you think for an MRI practitioner to also be a diagnostic radiographer? Do you think that's important just generally or not?  
(P) based on our conversation, ok if I have an MR candidate who is a non RT and an MR candidate who is an RT and... if their equal in every other aspect, I will hire the RT.  
(I) yeah ok because they can just do different types of roles and that's important to you?  
(P) but if my practice is MR only, if I own a standalone MR clinic and I don't have that need, then maybe the consideration would be a little bit different.  
(I) yes, ok. You may just say because somebody's done the programme dedicated to MRI, theoretically and it seems from what you're saying from the training, they should know more about MRI than somebody that you know, hasn't done this. I mean, that's the theory.  
(P) you know but when I explain myself, this is an MRI tech and this is an MRI Tech, ok this MRI Tech is also an RT, ok. So, they're equally trained in MR...  
(I) ok yes... so they've both gone through the programme, it's just their background? That makes sense, ok and do you notice any sort of difference in sort of professional values between the two groups and I'm thinking you kind of mentioned about patients and patient care but that's more to do with the fact that they the students haven't got haven't got the experience yet rather than the programme but if they're both qualified people with say two years' experience, would you expect any difference between the two?  
(P) no.  
(I) no ok. Fine, well the final question is just the score from one to ten, ok I have to read this out because I'm doing it... saying it the same for everybody... having discussed the professional aspects of this issue, on a scale of one to ten, where one is not at all supportive and ten is completely supportive, how supportive are you of practitioners with this going through, you know the... I have to use the right terminology, the primary pathway, entering MRI practice without a general radiographic background? Just on the whole concept of it?  
(P) I would say eight to ten.  
(I) ok. Well, I'm going to put eight I think. It will say eight ok?  
(P) eight. Ok, ok, ok.  
(I) that's great. Good, well I think we've done it. That's very helpful actually... [END]

TRANSCRIPT: CMUK.

(II) = INTERVIEWER.

(P) = PARTICIPANT.

(II) Excellent, good. So, the first question is what is your role in this particular department?

(P) I am a clinical manager for the MRI department. I manage two MR static sites and also a fleet of mobile MRI scanners, as well as an x-ray department and ultrasound.  
(I) ok and are you actually responsible for employing radiographers?  
(P) yes.  
(I) you are, ok and assistant practitioners?  
(P) yeah.  
(I) ok and what sort of imaging takes place in this department?  
(P) Primarily, we concentrate on MRI and so we have a 3 Tesla MR scanner and a High field open MR, so it's predominately MR. All of our radiographers are specialists in the MR field and supported by radiographic assistants team with MR safety training and prevalent in mind and also assistant practitioners.  
(I) ok but you've got ultrasound and other things?

(P) Ultrasound yeah... ultrasound is radiologist led and that's because we've just got a very small business for that. X-ray is also radiographer led... it's radiographer led, that's MRI radiographers actually go up and do x-ray, so they've had to knock the dust off their brain cells after a number of years being specialising in MR.

(I) well, that's actually going to be quite relevant obviously to what we're going to be talking about. So, how many MR practitioners do you employ and what... because you do assistants and radiographers, so how many in each group?

(P) at the moment, we have 23 MR radiographers, 2 of them will be trainees, so they're actually going on to a trainee programme, and they've had no MR experience before. We did have 2 assistant practitioners in MR, we now only have 1, the second one left to actually take a degree in Radiography and is at Cardiff at the moment.

(I) oh ok, right. Now, you're an MR practitioner? What was your training? I mean, you have a degree in Radiography or something?

(P) I did a diploma...

(I) you did a diploma?

(P) yeah, I'm the last year of the diploma and I qualified and I went straight into MR. So, I didn't go into general Radiography at all, so I didn't follow the recommended pathway of going into the NHS, getting a year under your belt deciding what you wanted to do. I literally knew when I qualified I wanted to do MR and there was a position that came up, a part time position here and I applied for it and they decided to take me on.

(I) and what sort of training did you do? Did you train...?

(P) it was literally then, 21 years ago on the job.

(I) right ok and since then have you done anything, particular courses or...?

(I) I've done all of the CPD. So, I was very clinical for the first... yes, it must have been like 16 years, so it's only the past 5 years that I've actually gone more into the management side. So, every course that happens to come up, I did but I didn't actually do any formal further education and that was just because of nature the job that I was in. They couldn't release me to enable me to do any further education. So, it was purely on the job and purely through years of experience of learning how to do it.

(I) yes ok, well that's great. Now, in terms of people you employ when you first get them, what's your opinion of their standard of MR practice when you just employ a new person in terms of their standard of education and their knowledge in MRI?

(P) yeah... I have found recently or over recent years their level of training or understanding has not been as I expected. To me, their knowledge was lacking or they had a reduction in their skill sets, whether that was a patient care issue and that would be through... I think, I was very off-school with diploma and we were very much in school for 2 days and you were with patients for 3 days, literally doing everything on the job and I think when it went to degree, very first off there was a lot of changes and tweaks that needed to have been done to that course. There was a real discrepancy in the patient care skills between the diploma and the degree right at the very beginning... that's what I noticed. It has improved over time but recently, I do have to say that some of the very young radiographers I've taken on that have come straight from university have gone into a graduate programme, they have lacked the general patient care skills in some respects.

(I) ok and what about their level of MR? Do they...?

(P) they have... they seem to have a reasonably good understanding of MR... when I took my diploma, it was 2 weeks in my third year and MRI was something to be revered and it was something new at the time. ... it's very much part of the syllabus now and so they do have much more of an understanding of MRI... basic physics and I think they have more exposure to MR departments and that's because they don't need to go to a specialist centre anymore, where there is only a finite number of MR's in the past, every hospital now has an MR department everybody can rotate through and so it's having the opportunity to be able to spend time there as well I think is a bigger improvement.

(I) so I mean, new employees, what proportion of them need extra training?

(P) I would say every one...

(I) ok...

(P) ... we target in our recruitment for experienced or people for training type programme. Those people I have taken on in my opinion with experience have lacked knowledge in some area in MR and that will be because they've come from a specialist centre that may have only done neuro or may have only done MSK and they haven't had a broad range of MR exposure. So, we're very lucky here, we... onco, neuro, musculoskeletal, abdominal, angiographic work. We see the whole gammut. Many people come from specialist places haven't seen MSK, so there is always elements of learning...

(I) ... that they have to do?

(P) yeah, they have to do even if they come as experienced MRI radiographers. In fact, I have identified that in one of our new recruits starting in January, she's from Oxford, very switched on about orthopaedic work, no neuro or abdominal work, so we're expecting a training programme to be implemented for that.

(I) how does that training take place? Do they go on courses or is it on the job or both?

(P) Literally when they start, it's on the job. They have exposure to that. Also as well, depending where they go in the MR depends on the specialist interest of that hospital site that we service. So, it could be that they get a massive exposure almost immediately but usually we bring them back here, spend some time... 2 to 3 months with them, assessing their level of competency, finding the areas of weakness, concentrate on those... now, whether that's through a log book type thing that we do. We also have peers reviewing their images as well and so, it's a lot of on the job work but there is a log book type of formalised programme. Not so much with experienced members of staff members, we have an expectation that they have a level of MR expertise... of course we give them training if there's a particular area they've never had experience in but the trainees at the moment, we've actually got a proper log book, training programme, we'll have assessments, we've got mentoring sheets and how to do assessments and that's something we've newly introduced with these new trainees. Prior to that we had nothing and it was yeah...

(I) that sounds good actually, you know it sounds quite formal and you know, as you say you've got documentation. Does everybody come on the MRI practice course?

(P) every radiographer that we employ comes on the MRI practice course whether that's days 1 and 2 to start or 3 and 4 depends on where their level of expertise is. Many have been on days 1 and 2 who have already come to us. In fact, it's amazing the amount of radiographers that we employ, they've already been on the course and they are aware of XX because of coming.

(I) oh right. So that's good for XX, I'll have that... well, that's great, that's given me a good overview. The next bit is I want to explore your understanding of the term specialist and specialist practice because through sort of the literature I've done, there's a huge variation in what people think is specialist practice and how they define the term specialist, ok? So, first off, we use the term in Radiography, specialist imaging modality, in terms of this department, what would you consider a specialist imaging modality?

(P) well, I understand out there MR is classed as a specialist imaging modality but this is our routine we do here and to me that's not specialist...

(I) exactly, that's what you know I thought actually because it is obviously in a department that does a huge variety of general Radiography, MR might be.

(P) I understand... in general terms I guess if you look at the NHS models there, you qualify as a general radiographer and you spent a little time in the 'specialist' areas and then you choose to undertake further, more detailed or in depth learning in a particular area which then you could class as your specialist area. That's how I would define it out there but there's a point where here we actually employ everyone's who's classed as specialist but they're not...

(I) they're not...

(P) from my point of view they're not.

(I) so MR and ultrasound and all of these really which would normally be deemed specialist is just routine?

(P) its routine. What I would see here as a specialist if that ever happened would be somebody who undertook an advanced practitioner training. So, reporting... to me that would be a specialist type of role for that radiographer... it's not specialist imaging but it would be specialist responsibility.

(I) right, well actually that was my next question. It was do you think specialism in Radiography is related to working in specialist imaging modality or is it the amount of responsibility, to do with the amount of responsibility that somebody has?

(P) it really does depend on where you are and where you're working is to how you interpret that. I think in the NHS like as I said, you can have specialist areas with 'specialists' within those specialist areas but here, I would say that a specialist would be someone with additional or advanced training, more responsibilities whether that would be a reporting radiographer, that type of thing.

(I) right ok. Do you think that someone working in a specialist imaging modality is a more advanced practitioner than somebody doing mainstream general radiographic examinations?

(P) no I don't because I think once you digress in your field whatever way you decide you want to go, you will have more knowledge in that area but very much so, I've not done general Radiography for a long time, I wouldn't say I'm a specialist in general Radiography at all. I've lost or deskilled in that area because I've gone in a different career direction. So, unless you are actually going through or rotating through the modalities routinely to keep your competency up, I think you just choose to go into a different area. So, from my point of view, you just go into a different area and you are not a specialist, particularly if you get what I mean?

(I) I do totally, that was the sort of thing, the question really, you know because we have sort of this notion of a generalist radiographer where generalists do the chest x-rays and the IVP's and that sort of thing and whether there any different actually in terms of what they do than people who do ultrasound or MRI which is specifically what we're looking at?

(P) they have a very important role, that's what you were trained to do. You were taught and you learned to a specific level to be able to a safe radiographer and adapt your technique in general Radiography I think is a fantastic art even now still. I would never say they're just a general radiographer because massive value in being a general radiographer, the fact that you choose to go somewhere else because you've got a specific area of interest, doesn't make you any better than a general radiographer.

(I) no ok. So, what do you think, if you were able to employ somebody who was just trained in MRI, not been a radiographer, they'd got a degree in MRI, what do you think the benefits to this department might be employing somebody to just do that over and above what you do now?

(P) well, the hope would be that if they'd undertaken a formal training programme in MR, they will come in with the underpinning knowledge of that area of expertise. So, there would be less likelihood of having to implement a training programme from the get go. This way, they would know that you can't go in there with a pacemaker or something like that. So, the benefits would be huge from an initial foundation, an initial grounding for that staff member, dependent on the type of training programme they'd gone through, whether there was clinical placements. It could be that they would have a really good core understanding of general basic MR procedures like scanning spines, knees or heads, a bit like the assistant practitioner course that's happened. So, I think there is a place for that, I think there is a benefit from that point of view, there's radiographers that have done a Radiography degree and gone into a graduate type of years training programme with other MR mobile companies and they come out the other end with a good understanding of the MR but they've got their underpinning Radiography as well. I don't think you need to be a general radiographer, trained in general Radiography and IRMA and all the radiation to be able to be an MR radiographer.

(I) ok...

(P) I needed to prove that point because we had 2 RAD assistants, they're very bright girls, had degrees in... I think 1 of them was in graphic design and another one was something completely unrelated to clinical practice but they had the qualifications and they showed the aptitude for patient care, they showed an interest in MRI, they were pretty good at picking up anatomy so we actually put them on your year's course and they both passed with flying colours and we have one now that operates pretty much independently. She can run her own lists and all we do is check with her work at the end of it, which helps support the MR department, particularly at a time when we couldn't recruit... radiographers...

(I) that is a huge advantage. I mean, thinking about other ways, I'm thinking things like if you know, people have focused on 1 thing whether they are more likely to stay. Do you think you might see a difference in sort of retention or...?

(P) I think you probably would as long as you also fulfil an ongoing educational programme for that person in CPD so that they remain switched on and engaged. You could lose that staff member to another MR department or wherever it may be. Whether... that comes down to you then I think is a company to whether you can retain your staff members and keep your staff members engaged. I can say, we retained our radiographic assistants who were probably have left and gone on to do other things by being able to offer them an assistant practitioners course in MR. So, we probably kept these AP's for probably 2 or 3 years longer than possibly than we would have done. I think they would have moved on probably.

(I) and again, thinking of you know, if you are employing somebody, do you think there would be any drawbacks to employing somebody who wasn't a radiographer and could only do MRI?

(P) in my clinical situation, probably not... I guess, in your NHS or your department that has a number of modalities that people roster or rotate through, that wouldn't be able to particularly happen with that type of staff member, they could only specifically be in that department. That said, a lot of departments for MR are very removed from the rest of the imaging department anyway and they have their own specific staff. If there are departments that have rostering through, then that maybe become an issue and from my point of view, our x-ray department is so small, we have enough radiographers that could actually cover that. We'd run into trouble I think if we took on completely MR trained only people with no underpinning knowledge of IRMA or any Radiography. That would potentially become an issue but that would be over a long time with a lot of staff just being very MR specific trained.

(I) ok, perhaps we're get on to that a little bit later actually. I'm thinking now of a person, you can perhaps imagine yourself, you're somebody who just got a degree in MRI and you just put a sort of focus on that. For you as a person, do you think there would be sort of professional benefits or drawbacks to that? You know, I'm just sort of thinking if you're focused in one area and the benefits of that and if you are limited to one area, the drawbacks of that? Does anything spring to mind?

(P) I think once you choose to do MR, you probably wouldn't look to go back to anywhere else anyway. So I think, once your very focused to do MR, the fact that MR is never expanding, there's always change in MR. There's no future that doesn't include MR, so there will always be the opportunity is to expand yourself or digress within your MR field. So, I don't think your opportunities would be limited, unless you were looking for roles actually within a department where they roster people through different imaging modalities but I have to say, I have seen more and more radiographers out there self-employed, MR radiographers advertising themselves as companies.

(I) oh wow, right I didn't know that. So, they go agency or freelance?

(P) yeah, I've got 2 radiographers working for me that are self-employed.

(I) ok right...

(P) and I've seen over the past 5 years more and more radiographer's actually becoming companies in MRI and actually doing locuming or agency type work around the country in MR and the more MR scanners there are, the more hospitals installing MR scanners, the more of that level of expertise is required.

(I) and so there isn't a shortage of jobs, you know people here, I can't get a job and you know, I only want to do MRI...

(P) not that I have ever seen. There will be problems for radiographers trying to get their foot on the first rung of the MR ladder. So, our brand new radiographer that started a week ago, he was recruited by us because he could not get a position in the MR department within his district general hospital because there's a waiting list of all radiographers who are already previously existing that want to move into MR. It's quite a long time to train people, so of course you know, when they've got somebody that's been there for 10 years know it's their turn, a year, 2 years or whatever. This poor soul that qualified 2 years ago is looking at 10 years' time you might be lucky to go into the department. So, he's applied to us and we offered him a trainee position so he can advance his opportunities of getting into MR. I think I've seen a lot of radiographers move from their hospital to get into MRI because they cannot do that locally as an existing staff member.

(I) no ok, that's interesting, I didn't realise that people were sort of so much in demand I suppose as very well qualified people that they are employing themselves. So, I mean in terms of the sort of competency and knowledge, I think you've more or less answered this but I'll ask it anyway. In terms of competency and knowledge to practice, how important is it for an MRI practitioner to be a diagnostic radiographer first?

(P) it teaches you the discipline to be able to read an image. So, you have the underpinning knowledge of how you assess an image in front of you and how you look for pathology. That said, an x-ray is completely different to an MR to a CT. So, I think as long as somebody's actually taught how to read the pattern within that type of modalities imaging that is produced, I think you don't need to be able to see, well a lumbar spine x-ray looks like in order to interpret an MR. As long as your taught the anatomy of the 5 lumbar vertebrae and everything around it, I don't think the x-ray or it didn't for me teach me anything that I could have interpreted in an MR. In fact, I would say that the x-rays, when you compare them to MR are very flat and 2 dimensional in many ways that it is very hard to translate it, you can see what it looks like laterally, you can see what it looks like on the MR but that did not help me learn. Mainly because... well, you have T1, T2... your contrast within your tissues are so different... there's nothing particularly like the x-ray in many respects that are just your densities from your radiation exposure. It was like going back to the drawing board.

(I) as long as you've got sort of general information...

(P) as long as and I would even say even more so for MRI because what I've found with MR being able to see in any plane what any level of obliquity that may be, I needed to press my buttons mentally for anatomy even more so than I did for x-ray because I was just seeing it in many other different ways because there was so much more revealed and I was just sat there thinking wow, they're quite amazing. So, I would say, you have a higher level of anatomical knowledge in MR. You have a greater degree of sensitivity towards interpreting the pathology because it's seen in many different ways and across many different scan sequences and there is a lot of anomalies or normal variants that you have to learn to recognise in I guess from the wheat from the chaff, you have to work out whether that is actually pathology or people can be like that.

(I) yes, it's normal variance.

(P) I think I've been very long-winded but I don't think you need to be a diagnostic radiographer!

(I) I'm just thinking sort of IOFB x-rays for example, would that be a problem here? I mean, if all your MR practitioners didn't know how to do that?

Do you have staff that could or not?

(P) we... I mean, we are all diagnostic radiographers, so we tend to both look at... 2 of us will look and say, there's no metal on that and you can precede, we always get a radiologist. Unfortunately here, radiologists report the work, we have no reporting radiographers, even though we've been on the course...

(I) but I mean in terms... obviously somebody's got to take them, the image?

(P) put it this way, if there was a course like the intra orbital to foreign body course, an MRI radiographer could probably go on that course and receive the appropriate training to do referral under IRMA, most likely actually given those tools during that training. So, I think there's even a test at the end of it. So, I think you've had your anatomy lesson, you've had your IRMA lesson, and you've had this is what orbits look like on x-rays, this is what orbital foreign bodies look like, here's a test...

(I) and just that, it could be incorporated in...

(P) it could be incorporated into the MR degree that area...

(I) a specific thing, so that an MR radiographer working alone perhaps or you know, could actually do that.

(P) other foreign bodies, implants that type of screening, you can identify that on your x-ray image. However, we don't interpret that, we leave that to the radiologist who's... they can interpret whether that's safe...

(I) the practitioner could still take the x-ray if they've got specific training in it? We're sort of getting to the end of this little bit here but if you had direct-entry into MRI via a degree in MRI, do you think that might have impact and if so what on their CPD of that person? I mean, at the moment where people who are radiographers and then they do training in MR and some go off and do postgraduate and most people don't, do you think that you know, getting a BSc in MRI which sets people off differently, whether that might have an impact in how far they go afterwards?

(P) I don't think so because I think once you've chosen to take that degree, that's probably pretty much the career path you want to follow and to be honest Cathy, I can't see anything ever stopping or contracting in the MR world, I think potentially going forward the world is going to be pretty much people's oyster.

(I) ok. I mean, do you think people might be more likely to do, I don't know PhD's in MR or a Master's in MR for example to advance their knowledge of MR into Master's level perhaps more than they do now?

(P) I would have thought so because I think once you've been given that... obviously it would be a fantastic grounding and underpinning knowledge in MR anyway. It wouldn't be much of a big step to be able to do a Master's or a PhD in that specialist area that you've chosen. I know radiographers that have taken a Radiography degree, diploma and then moved into MR, they have immediately gone into Master's and almost passed because of the level of... where do you have to do it... because I don't think they realised quite what the impact would have been or the level of understanding or knowledge they needed for that Master's. Whereas, if you specialise in that area in the first place, you have a huge amount of knowledge.

(I) well, that is certainly my experience and certainly, it is one of the sort of the primary reasons that I'm thinking down this route because I know how difficult it is to learn something new and go up to Master's level. It's not like doing an MSc in Radiography, where you're taking basic knowledge and just advancing it. So, this is one of my processes really. How important is it to this department for people to be registered with the HCPC in terms of employing them?

(P) it's a requirement... here... basically because it shows a level of competency that's been earned... radiographers, all bit it randomly... annual basis have to prove, through presenting evidence of their CPD that they've achieved the level that they're required to operate competently in that field. It's like a stamp, it's like a standard... I'm registered to be a radiographer because I've attained this level of expertise and I continue to operate and do so... I'm not sure about people being unregistered. I know the radiographers are protected title isn't it in the HCPC, so I guess that's where you're probably asking because they would be unregistered potentially...

(I) yes... I mean, this is an issue because at the moment the only title that the HCPC register is diagnostic and therapeutic Radiography.

(P) what about ultrasonographer on the back-end of that?

(I) well, I don't know actually. I know in Australia, they've introduced a degree in ultrasound and because you know, their equivalent, the HCPC wouldn't register them, ultrasonographers got together and set up their own registering body and bypassed it and that's you know but there has been a delay of maybe three years where people are coming out with this degree but couldn't get registered and they were practicing anyway and it's just, you know as long as there is a rubber stamp I suppose, you've obviously want that because you want some sort of you know standardisation I suppose but with new things it's a question of you know, if there was... if we suddenly started producing graduates in MRI but we couldn't get them registered... well, assistant practitioners aren't properly registered are they?

(P) no, that's right...

(I) and whether there's a leeway in this department and say, look, we'll take them in the hope the registration will catch on.

(P) I think we... it provides assurances to our customers and our service-users that the radiographers are all HCPC registered... UK based radiographers or whatever that may be. So, I guess it provides a level of assurance that people recognise that's a recognised regulatory body as well. Whether we wouldn't not take somebody on that wasn't HCPC registered... we've got an advanced assistant practitioner... we had two and you know, they had the certificate in MR, we're not worried about that they're on our key staff list that's on our web, so people can see the qualifications of our staff members, so I'd probably say as long as it was a recognised... formalised pathway, as long as it attained a certain level of clinical expertise, I don't think I would not, not take somebody on.

(I) that's it because I mean, obviously universities have to go through a massive validation process which the society of radiographers have to validate, so that's separate from the HCPC...

(P) so, that's what I would look for would be our next professional regulatory body or the society or whatever it may be or the Royal College of Radiologists, as long as it was recognised as a course by them that you had attained a specific level of expertise, I don't think I'd have a problem with it.

(I) ok right. Ok, last couple of questions now. One is quite a vague weird one. There are some people in Radiography now who are advocating that we should change how we run departments in that the patient, the radiographer should follow the patient. So, if a patient turns up multiple modality examinations, the same radiographer scans them or x-rays them. Now, that obviously involved being trained in all the modalities but by definition, not focusing and therefore perhaps not being as expert as if you focus on one thing. Now, in terms of the patient, do you think it is better for the patient to be followed by the same person and get that kind of holistic care if you like or to be scanned by a different people who are who are really focused and expert on that modality?

(P) well, apart from it being a rostering nightmare for your staff members and you would need probably thirty radiographers in a day potentially, a patient per radiographer or a radiographer per patient, that's fine if you have a radiographer that your patient gets on very well with as well throughout the day... I don't think I could be an advocate of that. There are reasons why radiographers specialise in particular areas. I think sometimes you can be a jack of all trades, a master of none... potentially, a bit like you are heading here of one... as it functions at the moment, I think it is the most appropriate way you would manage and treat your patients. I think patients expectations is when they go for an x-ray, they see that person and when they go for an MRI scan they may see somebody else. If it's a different day, that person may be working in the MR department and they may be lucky, they bump into the same person but a whole pathway on the same day, I just think it's not workable. Whether it has any real massive benefits for the whole patient population, it may benefit some patients, most other patients I think are probably more focused on, I want to get my whatever done and when am I going to get my results, regardless of who's doing it they want somebody to be nice, I don't think it necessarily needs to be the same nice person.

(I) no, I mean again other advocates going the other way would say if somebody has just focused on MRI for example, they are going to be really good at it and the patient will benefit from that as opposed to somebody that just you know?

(P) yeah, yeah I would say you know, just take MR case in point, if your very expert in MR and you've got a claustrophobic patient, you are very good at adapting your technique or making faster imaging, you are more likely to get better imaging, compliance from your patient and be able to scan them in twenty minutes than if you're not in there quite so often because it could take you forty minutes and you have a undiagnostic scan at the end of it. So, I think everyone has their place, an area of expertise and there are some people that are very good that can operate across a number of modalities, that's fine but I don't think it's hugely important that the patient has one-to-one with that person.

(I) ok. Alright, the final question and that is having discussed all of this, on a scale of one to ten, where one is not at all supportive and ten is completely supportive...

(P) ten...!

(I) ...you know what my question is going to be... ten?

(P) Yeah.

(I) so, you don't really have any reservations particularly?

(P) as long as it's an appropriate recognised, achieves a level of expertise and competency for that person, then we'll always be a place and a role for that MR radiographer. I can't see that they would ever not get any work or have a career direction wherever they wanted to grow all the way up to PhD...

(I) and being radiographer just isn't important being a diagnostic radiographer first?

(P) it's nice to have the title of being a diagnostic radiographer. The importance of that training in ionising radiation and whatever that may be, I don't think is important particularly.

(I) ok great. Well, that's it...

(P) put it this way Cathy, I'd take somebody on. I mean, we trained AP's because we couldn't recruit, couldn't find any radiographers, so it was I think John that mentioned to Peter, well if we do this course and it's a shame you don't do it anymore because I'd have another two or three if I could. It was... it was embraced by some of the radiographers and it was met with derision by a number I think because it's always a divisive thing, it's a bit like Marmite, some radiographers were sceptical and basically said, oh cheap radiographer labour, you're replacing radiographers that sort of thing but when you can recruit at all and that's...

(I) and they ended up being good anyway?

(P) and they ended up being good and my argument would be by the fact you have to go and check their work is like a failsafe sometimes. I would say radiographers make more mistakes sometimes than your AP because they don't double-check their own work and patients can be recalled whereas with an AP somebody is double-checking it and usually the AP because they want to make sure that they've done a good job will do that

extra sequence to cover that a bit more, put a few more slices on it or whatever it might be, I have to say I don't think I ever recalled a patient from an AP but I have from a radiographer.

(I) so and that is because your checking the work?

(P) because they're very aware that they're functioning in an extremely important role. So, that was sold to them right at the beginning, this is patient care you're taking pictures of patients and diagnosis depends on it and you could argue that with the radiographers as well but I think, they want a radiographer to check their work and see that they've done a good job and they don't want the radiographer to say, you haven't done this and you haven't done that, you are critiquing. I think if you critiqued a radiographers work prior to the radiographer getting it off, I think they would probably pull their socks up a lot more and probably...

(I) then radiographers should be critiquing themselves...

(P) Completely...

(I) and it's made it more like peer critique that irrespective of your role... I mean, obviously if we did go down this road, graduate MRI practitioners, they would be functioning as currently as your MR practitioners and not as an assistant practitioner role. So, they would be qualified to check their own work. So, you know it's probably more to do with peer critiquing rather than, you know... if you all had a system where everyday somebody was to critique... a critic irrespective of who'd taken the scan, it would probably raise everybody's standard up wouldn't it actually? So, anyway that's concluded it.

(P) I hope it's been helpful?

(I) yes... [END]

TRANSCRIPT: grad1

(I) = INTERVIEWER.  
(P) = PARTICIPANT.

- (I) ... going on in the background... ok, right. So, thanks very much for taking part anyway. So, I've just got a few questions to ask you about you know, your role really now that you've graduated and what you think about the programme. So, first of all, can I just... did you have any qualifications before you actually did the programme? Had you done a degree programme in something else before?
- (P) no, I just enrolled straight from my bachelor's degree and then came here to do MRI.
- (I) so, that bachelor's degree, just because I'm trying to understand is a three year... beforehand you do three years of general scientific things?
- (P) yes, general education courses.
- (I) right, general education and then you decided... and why did you decide to do MRI?
- (P) well, I was originally going to school for biology and pre-veterinary studies but then I decided that's kind of a long time and just a long time to get through vet school. So, I still wanted to be in the medical field, so they kind of told me about the new programme and I kind of researched into it and kind of found a little niche there. I really enjoyed the diagnostic imaging and you never know where that can take you, so...
- (I) yes exactly. So and you've been doing MR for six months have you?
- (P) yes, six months.
- (I) ok, so what responsibilities do you... I mean, are you a general tech or you know...?
- (P) yeah, I am a general tech right now. I'm technically a PRN but I'm in a small hospital, so I say this past Friday and this past Monday I was pretty much by myself running the department.
- (I) so, you do a lot of stuff on your own unsupervised and things?
- (P) yeah.
- (I) and I mean, is it... are you doing animals or are you doing people?
- (P) just humans for now.
- (I) and what sort of examinations do you do?
- (P) we do a wide variety and I work on like breasts, neuro-studies, MRA's, abdomen work, a little bit of everything. The only thing we don't see is like cardiac or run-off's or anything like that.
- (I) and do you do... are you comfortable sort of doing all of those unsupervised or...?
- (P) well, there are still like a few I haven't done a lot of like MRA's and stuff, I always like to have just an extra set of eyes to do that with but everything else I can pretty much get myself through without any problems.
- (I) ok, that's great and what did you enjoy about the MRI component of the course you've just done? What were the good bits?
- (P) I do a little bit of everything because I really have an understanding of like the physics and like the technical aspects of it where I feel like I might not have got that like on the job. So, that was always I feel like I have a little bit more of that now actually. You know, compared with the other technologist I work with.
- (I) and do you like that physics bit? Most people don't?
- (P) I like the science and understanding of it.
- (I) yes and do you find. I mean, did the previous three years that you've done did that help you in terms of you're...?
- (P) I feel like it did because I didn't have like a science base because I like physics and chemistry or a little bit beforehand and went into more depth with just the MRI.
- (I) ok so, it makes sense that it would help you I guess than going straight into it without any physics at all and is there any examples of where you think the programme could be improved? This is all going to be confidential by the way, so don't feel that you have to hold back.
- (P) only because our programme is so new, they're still trying to like co-ordinate everything I think. The biggest trouble sometimes is like some of the coursework between our different classes didn't line up exactly where they could have maybe put like our clinical subjects with our physics subjects as a kind of would have overlapped a little bit instead of jumping around so much if that makes sense?
- (I) ok, so it's the logistics of trying to marry up what you're learning in the classroom with what you do clinically?
- (P) that's right.
- (I) I can imagine it's a bit of a... Anyway, good ok, I can imagine the logistics is quite hard and that seems to be this clinical placement issue and how to marry that up with the theory I think but you've got lots of scanners in this area so that's good. So, from what your sort of experience so far of people that you work with and people that you've studied with, what do you think generally is the sort of standard of education that you've come across from various people? What they know or don't know?
- (P) most of them they know how to scan, they are very good scanners and know things like ok, you adjust the specifics, the timer, do this because someone's told them that. They don't necessarily understand like the background of what their actually changing on the scanner. Most of the TEC's that we work with in the clinic, in the hospital I work in, these have their RT's don't have that background. One other girl I work with, she has a bachelor's but that was like a ?? RT and they also specialise in CT and MR, so it is a little bit different.
- (I) ok and do you notice the difference then between her and perhaps what you know. Do you feel that you know more than the RT's you are working with?
- (P) I feel like I know definitely more background.
- (I) yes, I mean it would sort of, it would make sense that was the case. Do you sort of notice.... are they aware that you know more?
- (P) one TEC, I think she knows but she doesn't want to admit it but I think she kind of knows I know that I do... and another TEC, she does know because she knows all I did was MRI, so and like, even talking with the other TEC's like preparing for the registration, oh it was so hard, I had to study right up and I was like, I've studied really hard for it but I thought it was relatively easy compared to my studies and the tests I took in class, so...
- (I) that's interesting. Now, the next set of questions are ones that I'm asking everybody because I'm interviewing lots of different types of people, managers and academics and RT's etcetera but I'm asking everybody the same questions about specialism really and what specialist practice means because there's a whole different understanding of what it means and we use the term specialist imaging modality don't we in Radiography. Can I just ask you first what you would consider a specialist imaging modality from your perspective?
- (P) I guess probably it's like the dedicated work..MR?? [7 WORDS NOT CLEAR] (6.51).
- (I) I mean, the actual modality like you know, is MR... you know, general radiographer. I mean, what would be considered say specialist in where you work. You know, if you were specialising for example?
- (P) I'm not sure, I guess they just know MR like I like our director and team leader, they don't really know anything about MR, so they kind of look to us to teach them about it as well.
- (I) ok and do you have CT in your department and ultrasound?



(P) we do yes, it's in a different area of the hospital.

(I) yes ok. Now, do you think that if you are I suppose trying to imagine if you were an RT or just I guess, do you think that specialism is related to working in one of those modalities like MRI and CT or do you think it's more to do with kind of how advanced your practice is?

(P) I would think kind of working in a .. but I think working here definitely provides some knowledge to it but if you like have... what was the question

....

(I) the question... the thing that I'm sort of trying to get at is that very historically and traditionally, this word specialist kind of means you're an expert in something kind of thing. So, you take knowledge that you've already got and you get better at it but then we've got that we've got different modalities. I mean, you're not an expert in MRI because you've already started but you're working in a specialist modality. So, does that make you a specialist and what I am getting at and these are the sort of words, is it working in and specialising in MR, is it just different to being an ultrasonographer or a CT person or are you actually more cleaver or more advanced?

(P) I don't think I'm being more advanced in that we each have our strengths and weaknesses obviously. So, I don't think so. I think working in a might be a little bit. I guess you could consider [1 yourself like a specialist but by no means an expert.

(I) so no, no so it is... I mean, what you're saying is its different really and I would... I mean, from your perspective, I think it's a difficult one to answer because you only know that...

(P) yes exactly.

(I) you know, general sort of RT's can say, well, maybe one or the other but that's fine. So, I think you've actually answered this, it's a question do you think you are more advanced because you are in a specialist modality than somebody who does barium enemas every day for example?

(P) not necessarily because I don't know how to do a barium enema so I think this is a whole different knowledge set.

(I) yes, it is it's different isn't it. I mean and I would, I'm not surprised that you're coming at it from that perspective. So, what do you think the benefits are from employing somebody like you who's totally dedicated and just focused on MRI and a manager picking you to employ you? What do... obviously you have got a job, which is great. What do you think, you know why do you think you've got that? I mean, what are the benefits do you think to your employer having somebody like you?

(P) because I think we are definitely knowledgeable in just MRI's. So if...

(I) Yeah, carry on...

(P) issues do arise, we kind of know how to...

(I) Ok, right let's just start... for some reason it went a bit weird. So, just answer that question again, sorry where I was asking the question about the benefits of employing you?

(P) I think we have a little bit more knowledge of the background of it. So, if issues arise like with artefacts or equipment function, we can... diagnosis a little bit easier than someone who has no idea of what actually goes on in a machine, whereas they would just immediately call service or something where it could be just a simple fix.

(I) yes ok and do you think they might think that you know more and so... have you had to have any extra training for example from, you know from them or not?

(P) from my employer?

(I) yes.

(P) no, I have not had any extra training.

(I) because maybe somebody coming in without any ... who's an RT they would have to and what about the drawbacks? I mean, the fact you can only do MR and nothing else, has that been a problem or not?

(P) it hasn't been too much of a problem just because of the way the hospital is staffed but I can see it being a problem if say if you don't do very many MRI's in the hospital and they want you to fill in on x-ray or because I know in another hospital like the SSM Group, they only do a couple of MRI's a day, so their MRI tech will also take x-rays or do CT's whereas I couldn't go to that hospital because I don't know how to do that so...

(I) no and has that been a problem do you think?

(P) not at the hospital I'm at, no.

(I) no, it hasn't ok because I think you know that's an area of possibly obviously you can't and it might be a bit limiting and do you think that you... if you could try and imagine being somebody who does all sorts of general things compared to what you do, do... do you think you are enjoying doing your role more than if you were somebody who'd done RT and could do everything?

(P) I think so because I know every day I get to work and just doing MRI which is what I enjoy instead of maybe being tossed around and doing things that I don't enjoy.

(I) yes ok and are you concerned about sort of your employability in the future at all?

(P) I don't think so, I'm getting ready to move here soon and we'll find out how...

(I) ok, there's been lots of opportunities... did you find it easy to get a job?

(P) yeah, as soon as I graduated I kind of took a month off so I could study for the registry and apply for jobs and as soon as I took the registry I had... actually, I think I had the job before even I took the registry and then just by personal choice I waited to begin my job until after the registry was taken.

(I) right ok, right and what are your sort of aspirations for the future in terms of you know learning? Are you sort of going to continue with your learning in MRI?

(P) I'd definitely love to do that. I'd definitely love to maybe research or veterinary imaging. That's definitely my career goals like head in that direction.

(I) do you see yourself doing more like a Master's or PhD?

(P) yeah, I would definitely like to go back and get like at least my Master's and then see and go from there.

(I) yes and is that... has that got anything to do with the fact that you've got your Bachelor's in MRI or are you just... you sound like somebody who would probably do that anyway?

(P) yeah, it's something I've always been aspired to keep going and... you never know where you're going to go.

(I) exactly. So ok that's... now, in terms with your work... I'm just trying to explore now in terms of your working, how do techs view you as somebody who isn't a techs? You know, d they treat you the same?

(P) yeah, I mean like I said that one tech kind of doesn't want to admit I might know a little bit more than she does but all the other techs are great like Philip asks me questions and understand it like one of the other girls is getting ready to take her registry and she like she's always commenting on how intelligent I am and...

(I) so they don't feel threatened at all by you?

(P) no.

(I) that's interesting really but yeah, that's the case and are you registered with any like the ARRT?

(P) yeah, the ARRT.

(I) is that the only one?

(P) so far yeah and in a couple of months I'll register with the ASRT.??

(I) and there was no problems being not a tech when registering with them?

(P) no.

(I) they allowed you to do it?

(P) yeah.

(I) yeah because I'm trying to sort of understand really this registration business and who is happy to take non tech's but they were fine were they?

(P) yes, it's pretty simple especially through the programme like they made sure we had all the documents filled out and all our like exams documented. So, that was pretty simple really.

(I) so as long as you passed the exam, that's all that they cared about?

(P) so far yeah.

(I) so are you licenced in any other... are you licenced in the State or do you...?

(P) Missouri doesn't require an MRI licence in the State.

(I) ok, that makes it easier then. So, ok this is just a score really from one to ten. How supportive are you then of non-tech's doing MRI where one is not and ten is.

(P) Definitely a ten.

(I) definitely a ten. Ok that's fine. Now, my recording didn't do something in the middle and I'm not quite sure where we stopped. I've got more or less written down and I can you know remember because that's why I make notes really. It might be just when I listen to it back, I might you know, have to just through Marcie just try and remember and ask you what did you say.

(P) That's not a problem.

(I) because as I say, it sort of for some reason didn't work for a couple of minutes. Good, well thank you very much.

(P) Absolutely.  
(I) great, alright... [END]

TRANSCRIPT: GRAD2.

(III) = INTERVIEWER.

(P) = PARTICIPANT.

(III) I'll make sure they're going which they are. Ok, alright. So, can you first tell me do you have any degree in anything before you did the programme here?

(P) yes, I had an associate's degree in science. I have a bachelor's degree in education, elementary and special education.

(I) ok. Why did you decide to go into MRI?

(P) the question that everyone asks. When I... taught for eight years as a catered to primary special education teacher. I got to the point that about seven and a half years where I realised there were mounting paperwork, testing, evaluation requirements for the students I was working with, the potential students just waning support from staff, they were being cut that were carrying out the instruction that was designing. There wasn't just enough hours in a day to do everything and I didn't really like doing mounds and mounds of paperwork over the long-term. I saw a career councillor, he got me in touch with a bunch of tools gave me an interest inventory just tried to figure out what would be the best fit for me and the first thing that came up was Physician Assistant which I didn't even have close to the career recruits time available to go into that. In the same week, three people said, well what do you think about MRI, two in the healthcare field. I looked into it, really did my homework, figured out what I was getting into and did the prerequisite I needed and I went through the programme and here I am.

(I) so that's that. So, it was kind of a fit for you?

(P) oh yeah, it maximises my strengths and minimises my weaknesses absolutely.

(I) and in what way do you think it has maximised your strengths and minimised your weaknesses?

(P) sure. I'm a people person first and foremost, I get that through this job all the time. I mean, that's what it is, is a human services job. I'm interacting with people, I'm talking them off of ledges so to speak, going into this little tiny tube. I have math and science are some of my fortes. The physics is something I can do. I won't say I enjoy that but I can explain it to the students that are coming through that might have trouble learning it in courses... so just strengths. The weaknesses that I'm looking to minimise here. I have paperwork, I fill it out, scan it in, I put it down, I leave and I come back and it's a whole new day, as long as they don't make mistakes.

(I) ok and do you see that as a weakness or as a...?

(P) I see that as adding to what I find I like to do. That's what it's all about.

(I) right ok. So, when do you actually get the degree here? What year?

(P) 2011.

(I) ok and did you get a job straight away?

(P) yes.

(I) you did, ok. So, what are you actually... what's your job title? I mean, are you called...

(P) I am an MRI technologist two is my official job title. That means I've put in the time, I've learned all the protocols, I've done everything satisfactorily enough that their confident in my skills. There is a TEC three level that's for people that are specialising say in education and other things. There's actually a job opened right here right now that is more of a desk job than I would like.

(I) is that grading... is that something particular to here or is that... do you know if that's universal?

(P) I can't say for everywhere but I know the big hospitals around here there's... its more pay grade than anything.

(I) right ok, I'll have to ask Laurie about that. So what kind of examinations can you do completely on your own? Can you do the specialised things on your own?

(P) well, I just did a spectroscopy and perfusion study of the brain before you came in... that's a 3 Tesla specific one we do here... yes, the only things that I've never done and don't feel comfortable doing are Neonates, which are always brain studies... and we don't do cardiac, there is a specific cardiac section here where they have their own scanner.

(I) ok, so you haven't had exposure to that?

(P) no, that's the only reason why I don't feel comfortable with that.

(I) ok and so, apart from that you can do the whole range of examinations?

(P) from head to toe.

(I) ok and when you first got a job could you do that straight away?

(P) no, not at all.

(I) you couldn't, ok. What sort of training did you need... additional training did you need?

(P) I could do the basics.

(I) ok, what would you call that?

(P) I would call that... things that every facility does and we have a lot of specialised protocols here that we do. You know, I couldn't do a chest wall mass before I came here. I could do a head, C and total spine you know MSK stuff...

(I) so, it was really just exposure to a broad range of things you hadn't had as part of your training but in terms of what we call routine stuff, you could do it all?

(P) correct.

(I) so, what do you like best about the programme that you did here?

(P) well, the programme was thorough. There are other programmes around here that there is limited classroom time, just the bare minimum. I think that, I mean two semesters of physics, the emphasis on safety. The see I can't remember all but the classes like that but I think it went above and beyond to get me prepared to do exactly what I'm doing now. The clinical experience, I had four separate placements, one of them was here... actually two of them were here but it got me into an outpatient facility at a hospital... in another hospital right across the street here...

(I) it's all quite local isn't it?

(P) no, no, no one of them was in Newbury Port which is a good hour's drive.

(I) ok right.

(P) and but they try to get you in a variety of experiences just to let you see for yourself what's good and what's bad and to make your own decision.

(I) and you actually do the scans don't you when you're learning? You just don't watch?

(P) depending on the facility.

(I) ok...

(P) Depending on the facility.

(I) ok because you can't really learn if you don't...

(P) you have got that right and I take that... I take my experiences from there into this job now and when I have a student I say ok, you sit down, I'll tell you if you're making a mistake... take chances.

(I) that's good actually. So, what do you think could have been improved from the programme and this is all confidential? You can say whatever you like.

(P) a loaded question now... there are some online courses that would have been better in person. Physics for instance.

(I) ok... what are the online ones? Can you remember?

(P) first a physics class, there was a cross-sectional anatomy... oh and other like ethics, those were fine online.

(I) but physics you...

(P) the anatomy was fine too but the physics, its well when there's something that's intense and foreign to you at first, it helps to have someone to bounce questions off of than having an e-mail to ask for clarification and not quite get it.

(I) and would you say also the fact that you couldn't get hands-on experience in one of the placements, would that have been something they could improve or... you know the people...?

(P) absolutely.

(I) yeah ok.

(P) I mean, if you are a facility willing to take students and getting paid to take students frankly and you have them sit and watch that in my opinion is unacceptable and it's not the person who agrees to have the students there who's... I mean, it's not the TEC's that do that, it's the managers. So, yeah... I would consider that a fireable offence if I were a manager.

(I) yes, get some because I would too actually.

(P) it drives me crazy and people do it here. It happened when I was here and people do it here. It just drives me crazy.

(I) yes, well that is you know, when you sign a contract to take students, especially if you are a teaching hospital, you know you work at a teaching hospital...

(P) major teaching hospital...

(I) you teach and that action usually involves you actually doing...

(P) people don't understand that.

(I) no, no ok. Now, I wanted to just talk about what being a professional means to you. I mean, somebody who's been a teacher which is considered a profession, would you consider yourself in a profession now?

(P) well, first of all I'd say teaching is more of a profession in the UK and other parts of the country than it is here. That's a whole other story.

(I) and why would you... how do you define that then. I mean, I'm interested you said that? How would you define that?

(P) well, a profession I guess by definition is something that... a professional is someone who knows a great deal about it and gets paid to do something but another way I look at a profession is a highly trained skill that is looked upon as how they are trained and skilled and I will say I don't know exactly how it is in the UK but I know there are parts of Europe where teachers are looked upon the same as doctors and lawyers. Here, it's considered more of a blue collar position, even though you need a master's degree.

(I) so it's not linked to the education... the level?

(P) no and the pay is nowhere near commensurate than what it should be.

(I) so what you're doing now, do you think you are more or less of a professional than you were when you were a teacher?

(P) how do I think of myself?

(I) yes.

(P) I think myself as a highly trained professional... I met a retired doctor at a party and he said, I don't know. The way I look at myself, I call myself a technologist and he called me... oh he said you are a technician kind of like and he suggested it close to something else and I...

(I) so, technician being lower down the pecking order than a technologist?

(P) and it's just a word isn't it?

(I) it is of course.

(P) and it's just a word.

(I) yeah.

(P) right but yeah and I don't want to offend anyone when I say this but there are technicians that... I guess my auto-technician is one way of looking at it, which I value quite much and I think of that as a profession but yeah, I think of myself as a trained professional that's responsible for people and they're wellbeing while they're in certain environments and getting then the highest quality imaging in order to help them determine what's wrong.

(I) ok and do you, in terms of when you are working with TEC's with RT's who would learn while you are working with, do you consider yourself any different to them or more professional or less professional or the same?

(P) professional as far as knowledge of what I'm doing, I would say there are those that came up through x-ray, CT whatever that have really studied the matter that know what they're doing and there are those that just saw it as another step and did what they needed and they pressed the buttons that they don't really as much. Do I see them as professional? The other way I'm seeing professional as we're discussing it here is the where they present themselves to the patients too and that's a whole different way but the way we're seeing is just professional as knowledgeable of the field and prepared.

(I) not necessarily, I mean yes, you know how you... you know, I think that word profession comes as a lot of things and I think that could be a good work ethic and a good, as you say, how you are with patients is also part and parcel of that. Would you agree with that?

(P) Absolutely.

(I) ok yeah.

(P) if you're not putting forward your best foot and presenting as expected to the patient then the rest is all out the window really.

(I) yes it is and that... you were saying that is quite a variation in your experience of RT's let's say MR techs but they've come through the Radiography route where some you would consider as the same sort of professional levels to you but perhaps are less professional because they're not as knowledgeable or good with patients?

(P) absolutely but at the same time there are some that have gone to the same steps that I've come through that I might consider the same but those people aren't working at hospitals such as this.

(I) so it's not to do with the fact that some are RT's and some aren't, it's just the person and their attitude?

(P) yes.

(I) yes, ok. No, that's you know, very interesting and what you think the people you work with, what do you think about the standard of their knowledge in MRI. They're sort of knowledge and theory of it all and for modifying protocols and kind of having that working knowledge, their standard of education I suppose in MRI. What's your experience of that?

(P) I would say the ones that had education, primary education in MRI, such as... well, this programme that I went through. There was one that went through a programme where you had to get your x-ray then you could do something else and the same college experience. They had the best understanding of what makes a spin echo and what you need to change in order to optimise the image quality... there's not as much time or effort put on those and when your cross training that said I have a good friend and colleague who started out in nuclear medicine and he is... well, he is teaching there now at that university. So, it's not necessarily what path you take but more importantly how seriously you take it in the quest for understanding. Now, this person has an insatiable thirst for that and you can see, he leads me to a lot of resources that help me to become better but as far as the educational programme I went through, I think the courses, the instruction, for those that are really come into it, it worked extremely well.

(I) and the TEC's that have not gone through the programme, it's very variable you are saying that you were in it depends on the person?

(P) indeed, yeah.

(I) yes, ok. I mean, that's I think a common sort of theme really. So, you're... let's just talk about the fact that you are focused on MRI and you can only do that in terms of an imaging department. What do you think to the department of employing somebody like you, who's been through a programme specifically in MRI, what do you think benefits them? Why did they give you the job in other words over a tech who learns it you know, in the normal fashion?

(P) sure. Well, the standard of education that they know coming from just down the street is something that I'm sure helped get me the job. The fact I had a clinical experience here and must have done something right to show them that I could do the job helped but the... I think there have been... there are quite a few graduates of the programme I went through that are working here. That helps when they see success coming and hard work and a knowledge of the matter to allow to have better opportunities... is that answering what you want?

(I) yes, I think it is. I mean, do you think... I'm trying to sort of think, maybe think of the patient, what experience the patient has...

(P) with me versus somebody that came from Xray?

(I) well, yes I think, you know do you think the fact that you know MRI really well is better for the patient than somebody who maybe is cross trained on several modalities and maybe doesn't... I don't you know, what do you think?

(P) I'll tell you about the brain tumour spectroscopy and perfusion studies that we do. I will go back and look in our system to a previous study and I can... well, I'll look at the paperwork and I'll know who did it but I can tell if they knew what they were doing by looking at it and people that have been here for fifteen years don't always don't always know what they're doing and it's clear through the image quality what they got from the spectroscopy that they don't understand why they're doing, what they're doing, in every case.

(I) whereas you can do it because you've had the training in it?

(P) sure and with bandwidth some matrices and things like that, those are quite abstract but...

(I) so that was a good example though I think, you know the benefit that you can have and you know, I guess also you got a job here and you didn't really need much training. I mean, you said that you needed to have some exposure but you didn't, you weren't coming into this as somebody who didn't know about MRI as a RT might be coming in who gets a job and they must need time and quite a bit of training from other people in the department and you didn't need that.

(P) sure, I had a very strong base underneath me at that point.

(I) yes... yeah.

(V) have you come across any problems with the fact that you can only do MRI and you can't be rostered out to something else? Has that ever been a problem?

(P) I've been at this for three years and I love what I do. I don't think I would ever see me wanted to do something else...

(I) the managers haven't needed you is what I'm sort of getting at that you know, they couldn't... you are quite limited, you know you can only do...?

(P) there are people that keep their radiology certification for their x-ray and they will work per diem at another place doing x-ray. That's... I mean, true I am dead-ended so to speak, I realise that...

(I) that's not to say you couldn't widen it later...

(P) maybe on that, there is a large, very large hospital on the other side of town and they have a radiologist who says he doesn't want any MR Tech that don't have x-ray training. So, I will never work there.

(I) ok. and That doesn't bother you at all that you don't feel...?

(P) it bothers me that he's so narrow-minded, yeah absolutely...

(I) ok right...

(P) but what can I do?

(I) yes exactly. No, but...

(P) I'm not going to x-ray school just to work there. I'd rather not.

(I) and how do you... with working with RT time training people, is there any sort of division between you? I mean, how do they view you as somebody who isn't a RT?

(P) I haven't seen it so much here but in experiences I've had at other hospitals, I have seen a real shunning of sorts. They may see it as a threat that you didn't come up the same way as I did, you didn't work as hard to get here.

(I) was that when you were training? When you were... yes...?

(P) yes.

(I) yes, ok but not here since you've worked?

(P) no.

(I) no ok.

(P) no. We have a very tight knit community here. It's great.

(I) but in other places you've worked there was a bit of resistance possibly?

(P) there was

(I) yes ok. So, are you concerned at all about your employability? I mean, what if you had to move to another state or something? Does it concern you that you can only do MRI?

(P) no.

(I) no, you feel quite confident?

(P) that's the only thing I got in it for.

(I) yes ok. Yeah, so you don't mind, no? Ok, in terms of sort of what education you might do in the future. Do you have aspirations to go any higher do you think or is it enough with what you've got?

(P) didn't I tell you... oh, didn't I tell you the almost master's programme I went through too? I don't see furthering my education at this point, at this point. There's a lot of life left in me, I will never say never but I am extremely happy with the role I am in at this institution at this point... it pays well enough... I mean, I am comfortable and... I don't especially know what the next step would be if I were to do it.

(I) I mean, if there was an opportunity to do research in MRI somewhere, perhaps do a Master's or perhaps just I don't know, do some research and write a paper or... do you think because you've got this underpinning, a Bachelor's in MRI, do you think that... and you know you've had some academic learning in MRI that you are more or less likely perhaps do that than say a tech who has not done it? I know that's a bit difficult because you're not a tech but I mean, not a RT but I just wonder if it helps at all having done a Bachelor's in MRI to further...?

(P) perhaps.

(I) perhaps yeah ok. I know that's tricky...

(P) that is tricky.

(I) ok. So, I think that will probably... are you registered with the ARRT?

(P) yes.

(I) ok and so you didn't have any problems with that because the ARRT now recognise...

(P) ... the primary pathway...

(I) they do but they didn't always did they?

(P) no, it's been about seven or eight years.

(I) right ok and can I just ask about radiologists, do they treat you the same as they treat the RTs?

(P) Absolutely.

(I) ok right that's good. Yes, so they wouldn't probably know about half of them where you came from?

(P) I don't think they know at all.

(I) no.

(P) no.

(I) so, well that's probably good...

(P) as long as they need why should they?

(I) exactly, exactly. So, the last question is just about scoring who supportive you are of non RT's doing MRI where one is not supportive and ten very supportive?

(P) how supportive I am?

(I) I mean, yeah?

(P) Supported by my peers?

(I) no, how supportive you are of the whole idea of nonRT 's doing MRI like you? Do you think it's a really good idea or do you think there are issues?

(P) I think it's just as good an idea of somebody that came up through RT.

(I) so, you would say ten as a score?

(P) absolutely no radiation issue, ionising radiation issue. That's why they did it. People were becoming x-ray Techs just to go to MRI. I have a co-worker that did that before they started the primary pathway.

(I) so, you would score it as a ten would you in terms of being supportive? I mean, I imagine you would?

(P) computer images are read by radiologists. It's probably the only thing that connects me to an x-ray Tech or a CT or anything like that. The technology is ninety-five percent different and the way it's done is the same. I mean, we're all in the same department, radiology but there is no need to have a background in radiation training.

(I) so ok, I'll put you down as a ten.

(P) you can put me down as a ten.

(I) you know, that's what I would expect from somebody who's doing it, that you'd be supportive of it...

(P) and I'm supportive of the students that are coming through and everything, absolutely.

(I) well no, that's great. That's been very helpful actually and hopefully that's recorded alright with all the other stuff going on. So that's cool. I'll just... [END]

TRANSCRIPT: EXP 1.

(I) = INTERVIEWER.  
(P) = PARTICIPANT.

(I) Those both going. Ok, so thank you very much for agreeing to take part... no, it points that way. That's the microphone bit. I've just got a few questions as I said I explained to you about exploring the professional sort of benefits and barriers to sort of graduate entry into MRI because you work with graduate people I understand. So, first of all, I just want to find out a bit about you. What qualifications do you hold and why did you decide to go into MRI all those years ago?

(P) and you want a quick answer? I am ARRT (R) registered and I also when I worked for GE, I took the MR registry in 1999, I let that go because I went into business myself and opened my own MRI facility for ten years. Upon entering the trenches so to speak, I took the American Registry for Magnetic Resonance Imaging Technology which is called ARMRT...

(I) yes, I've heard of that, all of these R's.

(P) lots of R's. So and an extensive background. graduated X ray school in '86. From '86 to '91 I not only got introduced to MRI but I went to ultrasound school did ultrasound, I learnt CAT scan, CT on the job... excuse me, I do have a bit of a cold... and my facility in California that I worked

at that was getting MRI for the first time and I applied for the position and due to my... work ethic if you will I was selected for that position to head up the MRI department as the chief MRI tech and that's how it started and from there you know, General Electric healthcare, we had their equipment and they would come and do applications training and after a period of time they were learning stuff from me and they were oh we need people in Texas, would you mind you know, exploring the possibilities of coming to work for us and I did I went to work for General Electric healthcare doing MRI applications. I had seventeen States, I trained people all over the country, academic centres, and universities if you will...

(I) and how long did you do that for?

(P) I did that as a contract labourer for a few years and as a full timer for a year and that's when I went into my own thing.

(I) so you've been doing MRI since 1986?

(P) that's when I graduated from x-ray school. MRI from '89 I think.

(I) '89 right. So, here you're the lead MR tech?

(P) yes correct...

(I) it's alright, it's freezing isn't it?

(P) it is.

(I) and what... so what type of examinations are done here? Does it cover the whole gamut of stuff or...?

(P) pretty much. We do MR urography, all neuro stuff, different types of neuro study, do cardiac MRI, yeah I don't know if there's anything...

(I) anything you don't do... spectroscopy or...?

(P) we haven't been but I've done it and I've trained people on it. We don't actively have the spectroscopy software key turned on and one of our neuro RAD's would like that as well as susceptibility weighted imaging for their sports trauma clinic they have and what not, so that's going to be in our budget to give that all squared away.

(I) so I mean, obviously undertake all of those types of examinations even though you might not do them here, you have at some point obviously done it?

(P) yeah, I've done BOLD imaging, I've trained in seventeen States, I've trained tech's how to do BOLD imaging you know and function, different types of function imaging.

(I) ok so, do you ever get asked to do non MRI stuff in this department? You know, anything else?

(P) more administrative leadership stuff.

(I) but not sort of we need to take chest x-rays today or Bariums?

(P) no.

(I) ok.

(P) you know, I mean but I can. I mean...

(I) but it's not because one of the sort of things about only being able to do MRI. I mean, you're a generalist in the sense that you could do a whole range of non-MRI examinations. It's a question of are you ever...?

(P) not anymore.

(I) no but you could in you know, suddenly half the people couldn't make it in to work or something.

(P) quick story that relates to that. When I liquidated my businesses and sold all my MRI equipment to this company in Brazil, I took a year and a half off and then I actually went back to just doing x-ray and being a multi-modality tech and actually it was a lot of fun but I did MR as well and went to the OR and all that and from there, I took three Tesla job for some Mayo clinic doctors and that was a lot of fun, all I did was MR in an out-patient facility and bought their programme up a couple of levels and then ended up back here. I was born and raised in Michigan but my wife and I left right after college.

(I) oh yes.

(P) sunshine, palm trees.

(I) but it's not... you aren't actually required here anyway to... in other words, the fact that you are a generalist doesn't really make any difference here because the only thing that you actually asked to do is MRI and admin kind of things?

(P) yes MRI only but you do have to be registered. They don't hire non-registered techs anymore.

(I) yeah ok. So, this is sort of a general question here. What are your views on the standard of education of MRI practitioners in general... in terms of what they know when they come to work here for example?

(P) I think it's based on an individual personality trait more than anything else. I think it's based on a thirst for knowledge, either you have it or you don't. It's based on the fact that you want to do the best possible job than anyone can do or you don't. Do you want to punch the clock, do your time and go home? We have, you know every facility has both types and I see no correlation between formally trained MR tech with respect to that or someone who learned it on the job. None.

(I) it's just attitude really isn't it?

(P) it's here and here. It's a passion for what you do and either you have it or you don't. You can't get people to have it. You can try and sometimes you can kind of spark a little but it never lasts.

(I) so, I mean the people who don't have it, that spark how competent are they? I mean, in terms of doing their job?

(P) I think they can get through their job with little difficulty but there's not always the focus on getting the absolute best image quality for that patient's body habitus, for that's patients disease process. The patient comes in, there's a brain for you know, optic neuritis or whatever order, they run the protocol, they don't take into account the patient's habitus or ability to cooperate and they don't understand how to adjust your bandwidth or reduce your echo spacing when you take your frequency matrix up...

(I) yeah ok so they basically scan in protocol, the whole time?

(P) for the most part, some are more outside of the box than others but overall that's the majority of it yeah but that's the majority of everywhere I've been.

(I) yes, well it's interesting it kind of comes out in the protocol area. I mean, that's my experience too because you know and that's actually the lecture is going to be on this afternoon is the importance of being able to do that and how to do it and it's interesting in that you know, in fact in the test one of the sections is purely about that and the research I've done before this test, that's been the lowest score in section of the entire test.

(P) how to adapt to different...?

(I) yes, how to modify a protocol. So, it's interesting that you say that's probably where it's coming through this difference in attitude.

(P) like, if I look at an image and I say, how could you make that better? Deer in the headlights. So I came up first with a 256 by 224, why don't we try you know a 352 frequency matrix, you're going to lose a little signal, so let's take your number of signal averages up a little bit, lets increase your bandwidth that will bring some of your other parameters down and increase your echo spacing and I'll compare side by side and like for instance just basically an axial knee. You know, that's a good one because the one I've got here that will run at 256 by 192 and they weren't even interpolating that up to a 512 and now they do... I had to show them, oh I had to say to them.. of what you're doing what it can look like and it's actually ended up a three or four seconds faster. So, if you can understand the parameters and you're not on a Siemens or a Philips which I don't like either of them because they really limit the technologist's ability to really easily change and improve quality. I think they're all going that way, they just want button pushers the manufacturers. I don't like that.

(I) neither do me...

(P) that's the reality.

(I) that's another thing but that's, you know it's interesting that you say the difference in attitude and the level of education, that's where it comes out really I guess. So, the next set of questions is about specialism ok in Radiography because there is a lot of different terms or uses of the word specialist if you sort of look in the literature and a lot of variation in what people consider to be specialist practice ok. So, the next set of questions I'm asking 'very body who I'm interviewing ok, to get their perspective on what specialist means to you and what specialist practice means to you ok because the first thing is that we use the term specialist imaging modality in Radiography and it refers to modalities like MRI, they're referred to as specialist imaging modalities. So, first of all... I mean, in this department, what would be considered specialist imaging modalities?

(P) oh you know honestly everything except general x-ray just about. So, if you are doing special procedures and interventional stuff... interventional Radiography, MRI, CT, ultrasound, those are specialty areas.

(I) so anything other than general...

(P) Radiography.

(I) Radiography, right. Now, do you think specialism in Radiography is related to working in a specialist imaging modality or is it related to the amount of responsibility that somebody has? In other words, if you are an MR tech are you unusually superior to generalist tech's or do you just do something that is different to general Radiography?

(P) take the fifth, take the fifth amendment?

(I) there's no right or wrong answers to this.

(P) I think it varies. I think you can't put everybody in one box. I don't think... I think there are people that are where they are because they're not motivated and I think there are people who do go on to specialties that are more motivated and kind of a higher calibre of work ethic and person in

general... but it can also go the opposite way somehow technologist A is friends with technologist B is in MRI or management and you know, I think it varies and they might not be worthy of that opportunity to do something more specialised but they get it anyway.

(I) because I think you know, what's the key sort of things I'm looking is, is MRI a more advanced level of practice in general Radiography or is it just different?

(P) no, it is more advanced.

(I) and in what ways do you think it is more advanced?

(P) I think it's more advanced because of the ability to differentiate different tissue contrast pathologies, the amount of parameters, the imaging options you deal with in x-ray anymore with digital x-rays, you set a general technique, press a button and then get your picture and you can tweak it a little, you deal with milliamperage, kilovolts peak, time etcetera and not a whole lot else. In MRI you are dealing with a whole host of different parameters, imaging options and coils and...

(I) so but do you think that you then have to be able to learn at a higher level, practice at a higher level?

(P) sometimes.

(I) implying that as a generalist radiographer you can never be an advanced practitioner or you're never...?

(P) no, I'm not saying that at all. No, no because it depends. Some people like, they just like general Radiography, they have no interest in it and their very good at what they do in general Radiography, they're the best. I mean, if anyone in my family had to have an x-ray you know, there are certain x-ray people that I'd want to do it.

(I) you probably have certain MRI people you wouldn't want to do it too?

(P) or you find it was just them but yeah. So, I hope I answered your question.

(I) yes, though I think... I can sort of see, this is a sort of...

(P) shades of grey here.

(I) it is but I think you know, what's... there's not been much written in the literature about what being a specialist in an imaging department actually means and if you go to a cardiac facility, cardiacs routine, it's not specialist whereas if you go to a general department, cardiac is really specialist you know? So, you are right, there's a sort of context of it but I think this notion at the moment, you know we have this notion that traditionally you become a radiographer and then you would advance your knowledge by doing MRI, whereas what the post... the primary people are doing is they're coming in this and learning just MRI. So, you know are they more advanced than somebody... or are they just learning something different because they don't have general Radiography to then advance it into MRI because they haven't done it if you see what I'm getting at?

(P) so, when they come in depending on who they are, they are at a disadvantage clearly because they don't know their way around a hospital, they don't have nearly the experience in handling difficult patients that a radiographer would have, patient care and then there's the patient satisfaction issue which is huge in the US right now, patient satisfaction scores. I mean, someone who is coming in and going to an MRI programme and you know, depending on this programme they are enrolled in, how much time they get to actually do things versus watch and assist... yeah, there's a lot of different facets to... the whole picture you know and I do feel that just MRI, depending on how the programme is handled, is a disadvantage for people coming in. Usually when they come in they do not... know quite so much as the ones who say have been doing it for a year on the job.

(I) ok right.

(P) but they might be able to take a test (18.02) better.

(I) but in terms... so, that is coming out in their patient, dealing with patients and understanding patient care and the hospital system and you know, that kind of... obviously experience on the job is important I think whatever route you do it because it is when you actually, is isn't until you come to do the job and in taking responsibility fully for the images that you produce...

(P) I like a two year MRI programme too by the way. If it is just an MRI programme, an MRI tech I really think it's in their best interest to do one full year of learning MRI and multi-planar and anatomy and pathology and physiology, physics and one solid year of that just focusing on that and the second year four days of clinical mixed with one day of didactic training in the classroom, so they can review ...

(I) what they've learnt?

(P) and discuss what they applied with it, what they learned in the first year. I don't think it should be a one-year programme, it should be a two-year programme.

(I) that's you know interesting to know actually and I might be coming on to that, I'm not quite sure. Let me just check... right ok, I think we've sort of answered that one. Ok, what do you think the benefits are to this department of employing somebody who has just done this dedicated programme in MRI? Can you sort... what were the benefits... of having them?

(P) ... if... if they've worked somewhere else prior to coming here and were trained in MRI like the young lady who was sitting here, she worked at the Cleveland Clinic for three years after MR. So, she got exposed to many different things. So, it's a combination of her formal training plus the fact that she had been a student here, so she knew her way around the system and this company culture if you will. Plus, she got to experience a much larger facility that has nine MRI scanners and all they do is scan and so she's definitely clearly a benefit because she brings new ideas, she brings a different way of doing things and she does have some formal educational background and MRI so she understands a little more how to improve quality or...

(I) and because she's done the programme, she'd be better at that than somebody who's just come here having not... who's perhaps a tech but has not gone through that programme?

(P) not necessarily, it depends on the individual.

(I) yes, the attitude, ok yeah. I'm just trying to figure out you know, does the programme make a difference?

(P) honestly and I'll say it over again, it depends on the individual. There are people who will come out of the programme and probably never work as an MRI tech. There are others that will come out and be phenomenal MR tech's. It's about the person ...

(I) it's the person rather than the programme or the fact that they've focused just on MRI for a year or a year and a half or...?

(P) don't get me wrong, the programme is very important. I think we're working on having a very, very good programme here. I mean, I know I'm already seeing things that I want to change.

(I) well, programmes develop, I've been running mine for twenty-five years, and it's still under great change.

(P) oh gosh, I'll have to get your e-mail address.

(I) ok definitely. Ok, so we've looked at the benefits, are there drawbacks to having... employing somebody who can only do MRI and nothing else in this department? The fact, I mean IOFB's they can't be rostered anywhere else, is that an issue here?

(P) here in this specific department it is not an issue because when you do MRI you do MRI. Other places, a lot of other places in the US that they want multi-modality tech's, they want to be able to say, hey, you know, I know you are scheduled for MRI today but a CT tech called in sick, go over there. Oh, you know what, Jenny didn't show up and we have a Barium Enema you are going to go and have to do that. There are a lot of places like we are not that way and I think the patients get a better quality of care because of that where as you would call it specialised. So, the people that do their test, that's all they do. It's like going to a general surgeon or a neurosurgeon when you have a brain tumour. Do you want to go to the general guy, maybe he can pull it off and maybe not, he did once a long time ago?

(I) no, we wouldn't want that.

(P) no, so that's how I look at it and this place is really good about that. They don't want you... the only, I think the only thing in this department that rotates is there's a team of x-ray people, Radiography, general Radiography that have I guess proven themselves somehow or shown an interest and desire and there's two teams and they rotate into interventional radiology and then back into x-ray and the other team goes in. So, they have two teams, they are two layers deep to cover the interventional needs, which is a growing area.

(I) but everywhere else you know; it's specialises or stays in that but it's not a problem but you are saying that's probably unusual in the States in general?

(P) in general it is. In Michigan, there's the Dynamic Care, there's the certificate of needs stage, which makes it completely different than say Indiana or California or Texas where I was. If you are an entrepreneurial spirit and had the money and the capital to do it and you can do it and may the best man win. Here, it's not that way. Here, you could be the best on Earth with a pile of money and you're not going to open up an MRI facility, it's regulated by the Government and they determine...

(I) I'm trying to get my head around all the different States is a bit of a nightmare really.

(P) I'm sure it is.

(I) so yes, ok well, we're getting there now I think. Do you feel there are any professional benefits to being somebody who just focuses on one area of practice? I mean like job satisfaction? Your somebody who's done both. I mean, do you think it's more... I don't want to put words in your mouth but I mean, these are the sort of things I'm thinking of in terms of the benefits or otherwise of professional benefits of being focused on one area of practice... to the person?

(P) if you really enjoy what you're doing yes and if you are just kind of fell into it so to speak and then maybe not so much. For me, I like a mix of the hands on, the application, the training and then more creative projects creating inspirational presentations that get people into like say we're working now a urogram protocol which we haven't done many of them... we're doing more and more all the time. I like to put presentations together for teaching and I show how they should be set up and then outline you know, when you get the saline, when you get the lasix what sequences you

run... I like that, I get to do that but if I was just one of the staff tech's I wouldn't probably have the opportunity to do that. I get that mix so I like that because I would get bored if all I did was scan.

(I) but if you were of a generalist tech, you wouldn't have necessarily the opportunity to do the teaching you do or you wouldn't have the knowledge perhaps if you were just somebody who rotated around different modalities. You know, that focus doesn't it, it gives you the opportunity to develop educationally or research or whatever doesn't it, I think a bit more just doing all kinds of stuff you know I think, yeah. Yes, ok.

(P) yes, I agree with that one hundred percent.

(I) so, how in... I think we kind of covered this but I'll ask again anyway, how important is it do you think to have a general radiographic qualification in terms of employability?

(P) Oh, in the US... it's shifting but for the wrong reasons. So, in the US you are more employable if you have both even if you might never do an x-ray. You may never do an x-ray but somehow that's a requirement. So, I'd never agree with that and I'll go back a little bit on that. Ultrasonography, there's no x-radiation, most ultrasound tech's have never done an x-ray, they are specialised, they're ultrasound as you call them practitioners I guess ok. The hardest time I had with that initially back in the '90's was you had to have your x-ray licence first for the ARRT which is ridiculous. Why, tell me why, there's no ionising radiation, why is it a requirement? Is there a benefit to it, there might be but that is beside the point? The point is there is no ionising radiation, so there's no x-ray technologist training really required and nor really should the ARRT put a mandate on that, they've lifted that now and part of it isn't just because out of the kindness of their heart, part of it is because of the ARMRIT, they started pushing actually the schools for just MRI, that wasn't the ARRT, it was started by the ARMRIT and they're the ones who pushed that legislation and got the ACR, the American College of Radiology to recognise and ARMRIT registered tech as meeting their ACR requirements to become accredited by the ACR, which is huge. So, I mean you are seeing more and more that you don't have to be an x-ray tech. However, most places still want that.

(I) ok but they don't want it for ultrasound but they do want it for MRI?

(P) yes.

(I) ok. So but it is, it's a change of attitude. It's exactly the same argument, MRI doesn't involve ionising radiation either. So, you know if you apply those rules to ultrasound then there's no reason why you can't apply them to MRI.

(P) and they are now.

(I) and they are and it's slowly coming slowly changing. So, maybe in twenty years we'll have people...

(P) you know, I think where it started was because you know this, I don't want to insult you but when it first came about it wasn't MRI, it was NMR, Nuclear Magnetic Resonance and that nuclear term was, oh you got to be an x-ray, or Nuc med tech tit was a bad acronym...

(I) it was exactly.

(P) yes, we do base some of our imaging on the Hydrogen nucleus you know, well all of it basically.. but it's got nothing to do with nuclear medicine.

(I) no, exactly. So, ok well that's interesting. Now, just for your sort of educational aspirations. Do you have aspirations in terms of doing a Master's or a Doctorate or that kind of thing? What opportunities are there if you wanted to do that?

(P) I should do that... I'm wrapping up, I have my Associates and I'm wrapping up my Bachelor's in healthcare administration. I have a few more classes and I'm done with it and then I'll go and do a Master's. Since I have a background in business as well for ten years, I took a ten-year hiatus kind of from in the trenches, wear every hat. So, once I get into a Master's programme, a graduate programme I'm probably going to focus on entrepreneurial things that tend to lend themselves to our aging population. Services that are not being provided that can be provided, be that related to MRI or not and also education, I enjoy teaching. So, I will try and continue doing that as long as they'll have me and...

(I) I wonder how sort of typical you are... probably not you know because I'm asking that question because I want to see whether each... the different... two different types of practitioner are more or less likely to go on to higher education, you know and I'm not... yes, whether if you've got a bachelor's or an associate degree in MRI you are more likely to go on to Master's in that area than if you are a generalist tech who's you know, not done the programme. I know there isn't much of an opportunity to do master's in MRI I think it's only in St Louis I think.

(P) is there a programme?

(I) I think, I'm going to find that out in the next couple of days because I've heard that they've maybe starting one.

(P) why?

(I) yeah, I... don't take that as gospel, I don't know but I had heard but generally, I don't think there is really.

(P) I would branch off more into the business end of it and then possibly just continue teaching.

(I) yes ok, rather than do MRI to a higher level necessarily?

(P) I wouldn't mind you know keeping my saw sharp and doing some specialised stuff like you said, if there was a place that just did cardiac all day long you know that would be something that would interest me one day a week just to stay in, work for four hours.

(I) but just doing research into it you see because if you do a master's or a PhD, it's very researchy... so it's not really about what you can scan or your clinical exposure, it's more going into research and I'm just interested to see...

(P) that's why mine would be in business.

(I) exactly, which would be more... ok. So, do you think being a generalist radiographer makes you more or less likely to study MRI at a more advanced level in the future? Do you see you know, the primary pathway that people... if masters was available here, do you think they would be more or less likely to go on and do that?

(P) I think we only currently only have one employee who has as you say a primary pathway and the rest are through general Radiography.

(I) ok, so it's difficult to...

(P) but that's a shift, there's a shift in that paradigm you know and the programme has a lot to do with that and the changing programmes out there you know has a lot to do with it.

(I) I think it's a bit too early to tell maybe but it maybe that more people can come through you know, at the primary pathway will be saying, no I want to do a Master's in MRI or I want to do a Doctorate in MRI, you know if those are available. They want to take their MRI knowledge and to be more academic research possibly you know?

(P) not to say anything negative about the US, I can't speak for the UK, in the US I really doubt it you are going to find MRI techs's who want to get a Master's in MRI.

(I) and is that just attitude issues? I mean I am interested in that because there is a huge difference...?

(P) well, when people go into the programmes here their looking for, in my opinion because we have, you know I have a student right now who is very bright and his name's Ian, he'll be there tonight, he is very smart, he has his bachelor's and he was on an honours list, the Dean's list he's got a four point zero and he's very bright and he's going through the MRI programme to learn MRI... bang for buck there's not many Bachelor's programmes that you can get right out of the programme without knowing anybody and have the earning capacity that you do in MRI and Orax reg?? for that matter. I mean, when I had my own places, I had an MBA come to me and I had my Associates degree and an MBA came to me and wanted to go to work for me at one of my facilities and when I asked him what he was currently making, he told me around thirty five thousand a year and I thought, you have an MBA and I have my Associates and in the last year I cleared two hundred and forty thousand, ok I don't know there's something wrong here with this but this again goes back to that it's you, it's me, it's who we are. You can't make people choose these things but I will say that... have I answered your question?

(I) yes, I think you have. I mean, this sort of attitude is something we can talk about when the interview's over because I think it does sort of, it's not necessarily relevant to this but it is none the less interesting that you say that you very much doubt that tech's generally are going to want to learn at Master's level and that's...

(P) for MRI.

(I) for MRI, yeah.

(P) well, maybe one out of a thousand, which doesn't leave that many.

(I) which we'll get back on to that when the interview's over because I'm interested to know about it but it's not to do with this. So, do you think that you are respected more as a professional because you have a radiographic background or has that got nothing to do with it?

(P) myself personally, it's my entire background that might generate a little more respect from others towards me.

(I) ok, so it's not that you're a tech, it's everything, it's the whole package, it's more...?

(P) yes and I hope that doesn't sound arrogant?

(I) that's, you know?

(P) I mean, things I've accomplished with my little Associates degree most people never...

(I) no because I'm thinking like the doctors that you work with, you know in terms of their sort of respect of you as a professional on their level but it's the fact that you're a tech doesn't make any difference, it's more everything else that you've done that contributes to that?

(P) and if they have a challenging case and are not happy with the outcome the first time around, they'll talk to me about it and we'll get them back and we'll get one thing... and again, it's that protocol. Here's the protocol, this is what I run. You have to be able to think a little more on your feet and they recognise that and there's a third of us do that function more or less at that level and they bought me in here because I function at the top of that level but...

(I) fine. Something's just... when you were saying about the people who come in who are not tech's, you say they come in and don't necessarily know about the patient care aspect of things or understand how hospital works?

(P) not to the degree that someone who's been an x-ray tech for three years, no.  
 (I) would it be different to an x-ray tech who's just graduated. If you were to take an x-ray tech who's just graduated and the primary pathway tech practitioner, would it be the same do you think?  
 (P) it might be, I can't really say. It's so long ago that I did the x-ray programme.  
 (I) but you don't have people here who are newly-qualified tech's coming in here?  
 (P) in x-ray?  
 (I) yes.  
 (P) I don't know. I mean, I don't have anything to do with them.  
 (I) they don't come straight into MR with you necessarily when they've just graduated as a tech?  
 (P) as an x-ray tech, no.  
 (I) no ok because that is obviously possibly a different but it could be just experience rather than what they learn in the curriculum. You know, it's not a failing in the curriculum.  
 (P) no, no, no.  
 (I) I mean, it might be. I mean, I just was wondering... when you said that I just wonder if...  
 (P) no, I think you probably nailed there, I think it's probably more an issue of the fact that you know, they will come from x-ray to work in MR after doing x-ray for five years. So, they are real used to reviewing charts and the systems and patient care and handling and the culture absolutely. So, maybe that's probably more of it than anything. I do though firmly believe in a two year programme.  
 (I) because they'll have more exposure to the whole... I mean, I'm personally in favour of three year programmes if we were going to do this myself.  
 (P) there you go.  
 (I) ok, you know?  
 (P) and what's our programme here?  
 (I) it's fifteen months. Yeah, not long enough but that's something that will be exploring with the academics. You know, the best way of doing it. I think you need two or three years probably but...  
 (P) I think in the right didactic classroom setting and in conjunction with the right clinical site and the right person, three needs to be better screening of the people come into these programmes and some sort of aptitude test that says yes, these are your strong points, you probably would be good in MRI. They can determine these things now.  
 (I) exactly, yes.  
 (P) so I think that should be done before people are allowed in the programme. I know you have to you know, get people into your programmes to keep your programmes operational, I understand that is there an aptitude there to begin with or not?  
 (I) no, I mean I agree with you on that. I do. So ok, the last question what is a score. Ok, having discussed... I'll have to read this... having discussed the professional aspects of this issue, on the scale of one to ten where one is not at all supportive and ten is completely supportive, how supportive are you of practitioners with an undergraduate qualification entering MRI practice without a general radiographic background? In other words, how supportive are you of the primary pathway entry without being a tech, on a scale of one to ten?  
 (P) twenty... I'm just kidding. Again, it depends on the individual but...  
 (I) as a general concept though of having non-tech's coming in and focusing on MR?  
 (P) if they get... a caveat... if they get proper training and classroom and clinical and it's two years then I'm very supportive.  
 (I) so what number would you give it from one to ten?  
 (P) oh, ten.  
 (I) a ten, ok. I mean that's just some numbers I'm going to be comparing of different people that I interviewed.  
 (P) yes and that all... I can't tell you anything other than that when I just got done telling you about why it is required for an ultrasound tech not required and it is for an MR tech here to be an x-ray tech, which it isn't anymore but you... but I'd sound like a hypocrite if I said one.  
 (I) no but that's good, no that's great. So, let me just... [END].

TRANSCRIPT: EXP 2.

(I) = INTERVIEWER.  
 (P) = PARTICIPANT.

(I) ... going and that looks all super-doooper. Ok, that's cool. So, first of all thank you for taking part. I just want firstly to ask what qualifications, when I say what qualifications, you're a RAD TEC are you?  
 (P) yes.  
 (I) when did you take that? When did you complete that?  
 (P) 2006.  
 (I) 2006 and have you been doing MRI since then?  
 (P) yes, prior to taking the registry exam I went over to train like on a full time basis in MR, half way through 2004.  
 (I) oh, so you were doing MRI while you were doing your RAD TEC?  
 (P) oh, no, no. Sorry, in 2000 I graduated from nuclear medicine, so a nuclear medicine TEC by training and then, I started working in 2001. I think it was about April 2004 was when I made the conversation. I just left nuclear medicine all together. I had studied in 2001 a couple of courses, just like a part... it was actually here. They had two night-time courses for I think two to three hours once a week I think it was.  
 (I) and that was in MRI?  
 (P) that was in... no, that was MRI procedures and MRI physics...  
 (I) ok, evening courses?  
 (P) it was done in... I can't remember whether it was in one or two semesters but just evenings and you just attended for a few hours and that was it and then, I never finished the course because it required me to do clinical work, which I did not have time to do. I didn't want to pay for them to place me somewhere when I wasn't that interested at the time because I was working so much in nuclear medicine and then I... for years, I let it sit on the back burner and then, I got a little frustrated at work and I said, time to go. So, I walked down and spoke to the manager in MR and I had done some work experience there just to see what it was like and I said, I needed a job, I'll do what anything and previously a TEC from nuclear medicine who worked with me had gone down and he did ok, so she'd like why not? I train you on the job, you are pretty enthusiastic. So, she gave me a job you know and then I started working and she said, are you interested in doing the registry yourself? Oh yeah, at some point I guess but because you didn't need to I didn't want to... I didn't feel the need to take the exam and then there was an opportunity to kind of take the lead position and she said, if you take this lead position, I'd like you to take your registry, could you take it soon and I said ok. So, I just crammed down for about a month or so and then I sat the registry and that's how I got it.  
 (I) and have you done anything as a diagnostic radiographer?  
 (P) no, not at Diagnostic radiographer(3.06).  
 (I) no, ok. So, you were trained as a nuclear medicine person?  
 (P) yeah.  
 (I) ok, right.  
 (P) and that's how I... that's why I get the RT from a registered radiologic technologist. So, I have a radiation control licence. That's how I get the RT in my name, not an x-ray TEC.  
 (I) and to do nuclear medicine, what sort of course did you do for that back in 2000?  
 (P) I did a bachelor's degree. I'm from Australia, so I did a three... bachelor's degree in Australia.  
 (I) ok right, three year degree, ok and so you liked... why did you particularly like MRI when you got fed up with nuclear medicine?  
 (P) well, I studied a little bit of MRI... it was a part of my coursework and before... I didn't... I found it pretty mind-boggling when my physics lecturer was talking to us about it and I didn't think much of it but before I left the country one of the radiologist that I was working for, he said you know, you are pretty smart kid, he goes take a look at MRI, there's a future there. Even though MRI is very kind of slow in Australia because of the amount of scanners around, he said take a look at it you know, you'll be doing yourself a favour and I thought ok, sounds good and when I was working in nuclear medicine that TEC that left to go to do MR, he had finished a course in... somehow we started talking about MR, he goes oh yeah, I'm finishing my coursework, I'm going to... I plan to go into MR. He'd been working in Nukes for like twenty years or so and he gave me all the details about the school and the coursework and he said, you should do it because the hospital's paying for most of it you know and it is only a part time course at night time. So, that's how I looked at and said why not you know, it's got nothing else to do, I might as well...  
 (I) so, it wasn't anything particular. I mean, was you attracted by anything specific about MRI?



(P) when the time came, I was definitely interested in the shift work because nuclear medicine is pretty much just a daytime job because of the isotopes, besides on call there was no way to make that much extra work because there was five days a week. Some departments you are lucky for four tens. Other than that, there's not much room to pick up extra work. Whereas MR and CT all you heard about was how much overtime you could work in shift work and so forth and that's what got a lot of attention.

(I) more money?

(P) more money.

(I) more money rather than necessarily the sort of modality itself. Yeah, it was just the method of work.

(P) exactly but when I did start working, I appreciated the image quality a lot because I used to think nuclear medicine was pretty nice I mean but I started doing cardiac MR and I realised then, this is crazy, you know your comparing it to SPECT you are looking at this blob, so it was just non-comparable. So, that's when I started really appreciating it and I talked to a lot of my nuclear medicine buddies back home, hay, hoping an MR man, it's so much more gratifying you know. What I do miss about nuclear medicine is the pharmaceutical side of things but then here, the way that things are practiced in the US, you know it's just so much pushing the patients along, you know and you don't get to do a lot of the things where you... I don't know if it's the same now in Australia but before, we used to do a lot of the wet lab work, we used to do the BMD's, everything, everything was within nuclear medicine. So, you got a huge variety of different cases. All the weird little cases, you just don't do here because it doesn't make money or there's another department that does it you know, we don't even really do the thyroid ablations you know, that's another part of an endocrinology that takes care of itself. We've got nothing to do with that so the main things to do, bone scans, cardiac scans and the odd harder scan here and there, you know you don't do anything that's really neat and even now...

(I) ok, you don't miss it necessarily doing nuclear medicine, yeah?

(P) I don't miss it because it's just a factory you know?

(I) and ok, just sort of what role and what is your job title here for a start?

(P) I'm just an MRI... just a regular tech.

(I) and because I know, somebody was saying that you have like one's, two's and three's like MR type?

(P) oh ok. Yes, so depending on your years' experience I guess there's different roles you can have.

(I) so what number are you?

(P) well, when I worked... at the Brigham where my principal job is, we don't really have that...

(I) oh ok...

(P) but I'd probably be considered as a senior TEC because I've been there for a long time. At my other job where Laurie works, I'm a TEC2. So, the way in which they describe it is a TEC 1 is just like a new grad that is still kind of in training. A TEC2 is a huge cluster. A TEC3 is you take on an extra role like you do the QA or you do protocol management or your training people and so forth, you know?

(I) right. So, your responsibilities are kind of, for the majority of the scanning and can you do... would you say you can do pretty much everything. I mean, could you do... can you do cardiac or...?

(P) yes, so I've had, you know I've gone through quite a few roles, so I've been trained to do cardiac imaging, cardio-vascular. I've had the opportunity... you know, when I was a you know, working during the weekdays, I took over the role of doing the kind of vascular imaging. At one point, we were really separated, so all the kind of cardio-vascular imaging is done on one particular magnet. That was when I first moved to get a little bit of a raise. I wanted to make more money and my boss goes, go down there, learn how to do it because there's only a few TEC's that can or want to do it. So, that's how I got a bit of a boost and then from there, I wasn't enjoying it as much because the TEC I was working with who trained me and I learnt a lot then he felt as though I didn't need him anymore. So... we're good mates but you know, all that work stuff happened and he was the lead person doing that and I wanted out. I said, I'll come down and cover whenever there's a need but I don't want to be down here all the time.

(I) were you just doing that cardiac for a while?

(P) for a while yes. Just predominately doing that because there was only himself and myself that were able to do it. So, whenever he was sick then I'm stuck down there doing all those cases and that's when my manager said well, there is an open spot to do this applications. I said, what does that involve and she goes, well it involves you kind of running around and fixing protocols, doing a little bit of everything you know and helping training people and so forth. I said, I don't know whether I can do that I said... I'm only... this is I'm two years out of MR, you know I'm a junior person and she goes but your capable of doing it. I said, I don't know. So, I let that go on the back burner for a little while but then things got kind of miserable and I'm like, alright lets investigate this, is this the only way I can get out? She goes, yeah, that's the only way you can get out, you know other than that, I need you there.

(I) it's quite a good thing to get out into isn't it?

(P) so, she says, well take that, you're going to get a bit of a raise that always was a good way. I was like, ok fair enough, I've got nothing else anyway and I'd rather get out of this environment. Let's see what else is out there. She made me that person and that's when she had told me please take the registry because I need you to have that to be in this role.

(I) So, I'm just trying to sort of get when you initially went in and you just did cardiac...?

(P) no, when I originally came in, I was doing everything...

(I) you were doing everything...?

(P) but not cardiac.

(I) but not cardiac. Then you did cardiac but then you came out and did some of the apps and the training?

(P) did the apps and that's when she sent me everywhere like when you are acquiring different magnets, I went to do site visits and so forth. Any kind of visit that came along I kind of got to interact with them. I was semi-maintaining the protocols, so I went to meetings to each of the sections so I could understand what their needs were and so forth and that's how I kind of learnt to build protocols and stuff like that. I gained a lot of knowledge at that point because I was kind of forced to and then, I did that for a couple of years and then there was this huge pause because were doing a huge renovation downstairs. At that point, I didn't do too much because we didn't have as many magnets. So, it was quite stagnant and then my buddy, who was the chief TEC at the time and I heard that he was leaving and I thought crap, he's leaving like he protected me a lot because I have a certain kind of personality and something just roles out of my mouth and not Kosher and he was trying to groom me to take his role and said dude, I don't have the same demeanour, I don't think I can do it and he said no, no take it. I said, I don't think so and then this position came off at the weekend. This weekend position is a twenty-four for forty. So, I worked two twelves and I get paid for forty hours and that's it, I've got to take that. So, I took that and that's how I got all these days off during the week and that's when I started doing... [1 WORD NOT CLEAR] (12.43) at the BI and that was another learning experience. Meeting all of their radiologists, seeing how departments do things differently. I also got offered the job at the [1 WORD NOT CLEAR] (12.53) and at the [1 WORD not clear] (12.53). I went all over the place just trying to understand how things were done.

(I) so you've never been required... I mean, the fact that you are a Nuc MED TEC, nobody's ever asked you, you know their sort of nuclear MED, can you go and do that, you know?

(P) no, they don't really... I thought about doing like some extra hours because taking that twenty-four forty, I'm considered a twenty-four employee only. So, in theory I have sixteen hours during the week I can get paid straight time. I thought about going down and picking up extra hours but they didn't want me, I was an outcast at that time because my manager's... one of the managers at the time, he drove me out you know, he didn't want me to leave but we didn't get along, so he was the reason why I left and then I was telling one of the TEC's how great it was and they thought I was just trying to recruit and break apart the department, which I wasn't, I was just telling them, hay MRI is a good opportunity you know, so the didn't like that because one of my friends who now works the same gig as me, she's from nuclear medicine as well and all of a sudden TEC's are just leaving nuclear medicine and the nuc's in the department got very upset, so I wasn't allowed to step foot in the department there during working hours. Everything's fine now, we'll all good friends now but at that time it was just not a good thing because I was taking good technologists away and like I said, they care about you doing your job and then the like to sound as though they are trying to promote your career path and so forth but deep-down they just want you to do their work...

(I) ok I think we might just be touching on that a little bit later So, just to thinking about the standard of knowledge that people that you work with MRI have, how would you rate that knowledge? I mean, you obviously work with RT's and you work with people who've done the primary pathway and then you've got yourself whose another category of person. I mean, generally speaking do you think people know an awful lot about MRI. If we just take RT's for example that you would work with, what do you think about their sort of standard of knowledge?

(P) I think the standard of knowledge varies drastically, you know as you probably assume as well... the reason being is the laws in this country have allowed TEC's... basically a few years ago, anyone off the street could operate an MRI machine, it didn't matter you know and I think insureds [one of the outpatient MR's they used to let anyone, yeah you know, an... an EMT could sit in front of the magnet because there was no legal reason why you couldn't...

(I) no ok...

(P) so, lots of people and also in my understanding in other states this goes the same with x-ray and Nuclear Medicine you don't have to have degrees. The more you know, popular states yes, they have fully licenced... you have to have an associate's degree minimum so fourth and now they're slowly heading towards like a Bachelor's and so forth but it's not across the board, not in every state...

(I) it isn't, no...

(P) so, we get that as well here you know, people come from other states, they've had varying levels of education but they have a degree, sorry they have their licence so to speak...

(I) ... they have their licence?

(P) and you don't necessarily know what kind of education they've got to get to where they are now but no one cares because as long as you have a licence, it's Koshier for you to work.

(I) do you think that people who... have you noticed that somebody doesn't have any or much education in MR, have they much more likely to be a button pusher, who just kinds of does it and doesn't know why they're doing something?

(P) that's certainly the case. I mean, I don't want to sound rude or arrogant or what not...

(I) no, this is all confidential, so...

(P) because I take a lot of pride in my work, I like to do what I'm doing, I don't consider myself a button pusher and when I teach, I teach the technologists or my students to know what they're doing and why they're doing it and I can always refer them or reference them to some kind of text or journal and so forth and say, if you read this you'll understand why. On a day-to-day basis, I'd say ninety percent of the technologists I work with are just button pushers because that's what they've been trained to do, you know and it's... some of it has to do with radiologists or high management saying, don't do this...

(I) don't touch it!

(P) don't touch it because or you're going to get a QA, you're going to get written up or something. So, there's a certain fear that it's created and that's a bad culture to create but it's been like that for so long, only those that are very confident of what they're doing and I know very few... honestly in every department that I've worked in... at the BI I only know one or two TEC's there that are capable or they're willing to and they're senior TEC's, ok and then at the Brigham I only know one or two there and again, they're senior TEC's, you know?

(I) is it management that stops that do you think or is it the radiologist that stop that?

(P) I think it's a culture you know. Sometimes it has to do with the radiologists coming down on a particular scenario and sometimes a particular TEC and then instead of dealing with that one TEC or educating that TEC, it's just no, don't do this, do this in order or don't mess around with this, you're going to get written up and then the people hear these stories and it gets... it becomes a myth like, oh you shouldn't do this, you know and everyone's...

(I) you've come from Australia, yeah?

(P) yeah.

(I) and I teach a lot there, so I kind of know quite a bit about the Australian culture of things. Would you say that there's a big difference? I mean, Australia mimics more the UK in terms of this culture and perhaps the hierarchy between the doctors is God and everybody else is you know... would you say it is very different?

(P) it is extremely different, the education system. I mean, you probably know Francis Keech... Francis Keech, she teaches here in nuclear medicine. She's from Australia and she was trained in Australia, came over here and worked up her way here and how she runs the nuclear medicine programme at this institution here and I talked to her about the education because I couldn't believe it. I was training a lots of this... of the nuclear medicine students when I first came here, it's just part of the role because the students would come by and they'd chat at you and I'd be telling them about the standards that I you know, recently a graduate of you know, just turning up to class promptly or turning up to your lab on time. If your five minutes late, your late do you know what I mean? Just understanding what you are doing, the demeanour and the respect is very different and in Australia, you don't complain about your mark, you know. Again, when Australia, when you sit your exams, if it is fifty percent it's a pass. Ok, here it's seventy five percent and I can understand why it's seventy five percent, it's so easy, they make things so easy but they require you to pass at seventy five and when they don't get seventy five, it's a fail and I'll like well, I make my exams hard and if I get fifty, I'm happy because fifty has got fifty percent of the material or that may not be the case because you may not be able to take the test well, you know that's simply as it is but here, I hear people getting A's, straight A's and so forth and I said that's ridiculous, how can you get an A... if you're failing, how can you end up with an A at the end of the year. A prime example, my cousin, she's a straight A student, she went to Boston Latton in the North East and she went and did a Master's at the University of South Wales. She moved over there for a year to study and she was shocked because being used to getting straight A's, she all of a sudden struggled to get a credited average and she was petrified, she was like what am I doing wrong? I said, you're not doing anything wrong, you are passing what else do you want, you know like when I go to graduation ceremonies in and I here Cum Lade [and there's fifty of them out of 150 students, it means nothing. My class, they had three students that had an HD average, that was it, you know an HD average is impossible with eighty five percent. Eighty five percent doesn't sound... that isn't even an A you know but that's almost impossible. In most of my assessments that I got an HD maybe half a dozen times in my three year programme I said and I was proud of that. I said, I wasn't the best student, looking back at it now, I'm sure I could have worked harder but I just got by because that's all I cared about I said, I needed to pass, I said I'm not trying to strive for this A thing you have here you know whether you have some kind of requirement you need to get a certain grade for your scholarship and so forth. So, definitely education is very different.

(I) yeah and I think also the sort of working practices are as well.

(P) the working practices, the work ethic you know and I think sometimes it comes down to because you see so much paying students here, they just feel as though at the end of the day if they're paying money they deserve the degree you know and there's something to be said there as in Australia we didn't pay for it, you know it's a privilege to go to university, you know the Government helps you pay but you are out there to try and prove yourself to get a job, it's very competitive. Here They feel as though I'm paying I should finish the degree, then the work thing is its own separate thing. Some of them are quite...

(I) because that comes after of course. The education's one thing. Can I just... I just want to talk about being a professional because there's lots of definitions... people define what being a professional is. I mean, would you consider being an MR TEC a profession? I mean, would you consider yourself a professional person?

(P) I believe when you enter healthcare in general, you should become a professional. A healthcare practitioner is supposed to be a professional. Do I consider myself a professional? I do... coming to work you know, I feel as though I have a job to do to deliver healthcare, help people get through an exam. As small as that... to me I think it's a small part in the whole healthcare equation because I spend so little time with them. Like, when I look at a nurse, I said there is definitely a healthcare professional because they spend so much time with a patient. The more time you spend with a patient, you feel as though it's a more professional thing. You know...?

(I) ok, so it's time with the patient, not necessarily your level of training? Would you say that doctors are more professional than say TEC's?

(P) yes, you see that's a good question. Depending on what doctor you're talking about here you know. The typical radiologist here, I don't feel as though their very professional because they don't interact with the patients so much. Are they medical doctors? They have a medical degree. Are they professional at reading images? Yes but in terms of the healthcare, maybe if you could split it up into what they do, then they're a professional at what they do, you know that's the only way that I can describe it because in Australia again, I always refer back to Australia because that's what I started off with. Radiologists or nuclear medicine physicians at least, they interview the patient. There was some kind of patient report at one point of time. Whether it's after the scan is done or before the scan is done collecting information about the patient, just giving them an idea about things. I don't know if that's still done but certainly it was never done here. When I first started work, I got the patient all ready, just the way I did it back in Australia and I went to get the nuclear medicine physician to ask them to come and interview the patient. Then he laughed at me saying, what are you doing. I said, don't you interview the patient? He said no.

(I) so, it's different here than in terms of...ok, yeah it's just I'm trying to... there's lots of definitions what being a professional is. Some people say you can't be a professional unless you've got a degree in something. You can't be a professional unless you've done research or something and it's... you know, is a builder a professional person? You know, who hasn't got any sort of formal education and I think it sort of comes into this team work in a hospital is that you have doctors and TEC's and people who come into MR who have not done... been a diagnostic radiographer or a nuclear medicine person and they've come in. Are they any less professional? Do you work with people who've done the primary pathway?

(P) yes.

(I) how do you feel you are at the same professional level as them or do you see them as something different?

(P) I feel that depending on... I guess some of them I believe are not as... I won't use the word professional because I still believe they carry themselves as professionals and that's the same with RT's, I think it comes down to the individual because I don't believe... I've taught some of these student's and I know and work with some of them and they're very good at what they do. Depending on who you are and how you go about doing your job, you can be an excellent MR TEC, you don't need to have started off as an RT. When I first started, I thought you needed a firm background in radiology whatever the background was but I've come to learn that no, you don't have to, it's helpful but then only if you're willing to use it because I see lots of x-ray TEC's or RT's that are doing MR and then they don't use their knowledge.

(I) so what do you think the knowledge they could use then? I mean, when you say... I'm just trying to figure out what the differential... the difference is between an RT... what skills do you think they would have that somebody coming in without that you know?

(P) Its bringing your experience doing x-ray and so forth and actually applying it you know? Look what you did say running an x-ray... x-rays doing chest x-rays you make an adjustment here and there to make the image better. If you can apply that same knowledge to do an MRI instead of just being a button pusher. If you become a button pusher as an RT, then that's essentially what we train or we teach you know, the primary pathway to do. We teach them to do a scan, we don't teach them to make the adjustments and we do MRI, so if that's what everyone's required to do then

everyone's an equal, do you know what I mean? That's what my argument with a lot of TEC's is with oh, there's more of these MR TEC's coming on and I said, hey it's the survival of the fittest. I said you're doing exactly what they're doing. You hopped into MR because you wanted a job, you want to make money. These kids are doing the same thing. I said, what you do is not any better than what they do, that's all it comes down to I said, in fact if these kids are providing a better experience for the patient because their younger, energetic and they care, whereas all you care about is the pay cheque at the end of the day, then you know it's...

(I) it's the attitude?

(P) it's the attitude you know. So, that's what I feel it comes down to.

(I) so you're... I mean, I'm interested because you've been a nuclear med person. Do you think that the fact that you've done nuclear med before, has that helped you in any way in terms of doing your job as an MR person do you think? Are there anymore skills that you've bought in on that?

(P) well, I did a lot of IV's before, so that helped, you know just working in the field... those years working in the field... the three years studying in nuclear medicine... I think it's helpful but in the end it's what you bring to your job and what you're willing to you know, all your experiences, all your emotional interactions with patients, your worldly experiences like my mother has cancer, so I take her to her appointments and so forth. Those experiences make me a better technologist because I know what I want... how TEC's should be treating a patient because I see how TEC's treat my mother and so forth. Those things I think are a lot more important than what you can teach in a classroom because those things I think made a greater impact on the patient experience than anything. I mean, I used to... all I cared about was how pretty the picture was and I used to get frustrated at patients moving. These days, I don't care if the patient moves, I stop the scanner and see what I can do. If I can make it a better scan with them moving, you know can I make it a faster scan so that their less likely to get to the point where they've got to move or they can hold their breath, those things I like to manage the scan and still create diagnostic images. I think that's important too but the most thing that is really important to me is getting that patient through no matter or not I get a good picture or not, at least help them get through that experience. If I can't get the scan, I can't get the scan, the first thing is taking care of that patient, you know? It's not the picture.

(I) patient care is the key thing I think in terms of that. So, just finally I'm just trying to score... in terms of people doing MRI who have just come in and have got perhaps a degree in biology. They haven't got any imaging history but they come in and they do the programme here and then there an MR technologist. How supportive are you of that concept of non-radiographers as I'm calling them, where one is hate it, ten totally support it? What number would you put on that?

(P) I am a ten because you have to. I can't stop these programmes from existing, it's part of the system now. I'd rather work with a person and hopefully find their potential because they're going to be treating... they might treat my family member. You know, I'm totally supportive. Would I rather people have some other education beforehand, that would be great...

(I) but it doesn't matter...

(P) It doesn't matter...

(I) but it doesn't matter what it's in necessarily...

(P) as long as the person's willing, that's what matters really.

(I) right, well that was very useful actually, it was quite... I didn't obviously realise you had an Australian background because that gives me another slant on it because you know, there are things happening in Australia at the moment that mimic what could happen in the UK but they're very different as well you know because understanding the American system is an absolute nightmare.

(P) yeah, it is pretty crazy.

(I) so yeah... so that... [END]

TRANSCRIPT: academic.

(I) = INTERVIEWER.

(P) = PARTICIPANT.

(I) Okie-dokes, I'll start that one. Cool, right, I think they're both pointing in the right direction. Right, thank you for agreeing to take part anyway. I just want to sort of get an academic perspective really from somebody who runs a programme... because obviously there's different sort of viewpoints of introducing sort of non-techs into an MR role. I just wanted to get a bit of a background about the programme and why you know, why it was introduced and what problems if there have been any basically. So, first of all, what's your role in the MRI programme?

(P) I'm the director.

(I) you're the director and what does that involve?

(P) oh, I... well, I've developed it, Austin of course has helped, He's the clinical co-ordinator but everything falls to me. Right so, I decide on the curriculum, the text books and clinical sites. I mean, you know I developed it and put it together. So, in Austin's role, he takes care of the students when they're out in the clinic, ok but I go out to some of them too because I'm not willing to give up that piece. So but if there's any issues then they all come back to me.

(I) ok, so it's the sort of the academic rather than the clinical side of things that you've develop and co-ordinate?

(P) right and it's all for that professional year and then we developed the curriculum but we copied pretty much how we changed a few things but we very much copied the other programmes in the department because they work right for the bachelor's degree but the MRI, I mean the coursework, the text books, they were all you know developed all of those.

(I) ok and what qualifications do you have? I know you're not a tech but just...?

(P) well, I'm an MRI technologist.

(I) you're an MRI Tech but you were in nuclear medicine is that right?

(P) nuclear medicine Tech, correct and in nuclear medicine, we were here at the VA and they had one of the first magnets, so I was able to run the magnet because at the VA they had Tech assistants and then their technologists had to have Bachelor's degrees. So, there was only a couple of us so, I got to run the magnet there. So, then I got into MRI but then I... I took the, I took the ARMRI registry because that was the only registry I could take at the time because the ARRT wouldn't let me in because I was a nuclear medicine technologist and not an x-ray technologist so they wouldn't let me and I wanted to be registered so I did that and then I went back to school for my Master's to be able to do just this, I just didn't want to be here but to be able to develop an MRI programme.

(I) and you did it in... I can't remember what you said, what did you do your Master's in?

(P) human resources.

(I) human resources, ok.

(P) they didn't have very many options and I figured human resources would take me just about anywhere and it's good to know all those things with human resources which you can say, can't say, can do, can't do... everything else you know and that was that or a Master's in business and I don't want to do that, I don't want that end... I don't want the financial end of whatever, so...

(I) so, what was the rationale for setting up this course?

(P) for the bachelor's degree in MRI?

(I) yes.

(P) I have wanted to do that for quite a while because I think it's necessary because there are technologists out there that don't know, they don't know what they're doing... their button pushers and that's a scary thought. You know, you can have the mobile technologists that go in and they have their set... and it's just scary and then you have all the MRI safety issues which is huge and that safety has always been you know, a very important aspect right. So, you know most of the time, now anyway it's not usually the technologists fault right but I mean, it hasn't always been that way. So, there's just a lot to it and to be knowledgeable in your field. I mean, I had the Bachelor's nuclear medicine, you know in nuclear medicine and I thought that needed to be in MRI because MRI is very technical, the physics can be really scary for somebody you know and in fact people that have been trained on the job, they don't have the background, they don't know why you know, how things work, they can't change parameters knowledgeably and that's why you end up with crummy pictures right and things that take too long. You know, we were training a tech on the job and she'd done twenty three sequences and still didn't have a decent one. m, the ER with my daughter, she went could you please... she had orientation problems... he had her feet first, put her in head first, femurs were upside down, she can't figure out... ok, so it's those kinds you know and I think we need more knowledgeable technologists than button pushers... MRI's very technical and there's a lot to it and to just raise the bar.

(I) did you consider doing an associate degree? I know there aren't many Bachelor's are there in the country? Most of them are... so, all... yes, so you didn't and is that just because you had a Bachelor's in nuclear medicine and you just thought it's just got to be that or...?

(P) probably, that plus you know, I worked in a place that had a Radiography programme you know and they didn't even get their associates. If they did extra classes at the community college they could get their associates... So, they're spending two full years in getting maybe an associates right and MRI its an advanced modality, so I just... it wasn't even an option to me. Maybe if you had started at... I just don't know but now... you know what, it didn't even occur to me to be one of the associates degree for MRI.

(I) so, can you just briefly go over the curriculum again for this course. I know you told me yesterday but if you just briefly tell me?

(P) ok, so for the entire bachelor's degree or...?

(I) yes, if you can just... no, just tell me the MRI curriculum because you've given me the information for the prerequisites, so that's fine.

(P) so the MRI is their senior year, we call it the professional phase...

(I) and that's the fourth year isn't it?

(P) yeah, it is a full twelve months, so it's a fall spring and summer. So, in the fall is didactic coursework all MRI and we have... you have the courses there, you know the physics which is taught by a physicist and an anatomy and pathology clinical MRI instrumentation and then patient care and MR safety. So, those are all MR directed courses, ok? In that we have an unearthing of medical terminology as well but anyway, then the last two weeks of the fall semester they go out into the clinic. So, we end early but then they get two weeks less... a Christmas break than the other students and they're out in the clinic until mid-August and they've finished. So, they rotate through... right now, its four different sites. We started with three and that was a little bit long I think, then they get their exposure to... if we can do four, we can at least they can get the three top vendors, exposure to and they're rotation are eight and nine weeks a piece.

(I) ok right and so they do on all the three types of scanners?

(P) Siemens Philips and GE.

(I) and they see a whole range of examinations?

(P) yes and I don't know if you are familiar with the ARRT and they have a list of exams that they have to have if they are a primary pathway which we are a primary pathway. So, they have a list of exams they have to be proficient on before they can sit for the exam. So, then the students have that list and we have all kinds of paperwork because you have to have documented and how many times it takes them to become proficient in the exam...

(I) ok, just hang on for a moment... I just noticed that it had gone a bit weird, we'll start, ok... I don't think it had... just carry on because it is fine... the other ones didn't but it seems to be doing that. Anyway, carry on...

(P) yes so, so they have to have documented about how many times it takes them to be proficient...

(I) yes...

(P) so, they have all this paperwork out in the clinic that they have to keep track of and the clinical instructors out there, you know they are registered technologists, MR technologists and they have to sign off on all their work. They don't necessarily have to be the one teaching them, it does have to be a registered technologist teaching them but the clinical instructor has to be confident that whoever is signing off on this is capable of teaching them appropriately.

(I) and how do you know that? I mean, do you make an assumption that the TEC who is teaching them, knows what they're doing or... do you give them any training?

(P) they have to be registered and the clinical instructor we have spent a lot of time with and they are part of our advisory team and they help make decisions on if we need to change things or whatever but we go out like I said and we visit the clinical sites so we talk with the clinical instructor, and the technologists and the student. So, we get a lot of feedback from the student and also those technologists. You know, this one was great and their going into this and we'll go out and they'll say yes, they pull out their books and their showing me this and their explaining this and their doing... so we're making sure that their being matched with technologists who are going to help them and we quiz them about where they went in the fall and how their applying it out in the clinic and so, I mean the students are pretty good indicators of who their learning from and who they feel like their kind of...

(I) and the co-ordinator must help because that's sort of the link between you and the clinical sites isn't it in a way?

(P) well, Austin's the clinical co-ordinator so he has a lot more to do with the clinical side than I do right but I kind of like going out there. We do have a relationship with all of them and the clinical instructor or the preceptor as the main... that's the go to person for the students and their usually you know, every place we that we have we have their best tech. So and we've got them from the managers like the ones who pick them out and say...

(I) and their happy to teach? I mean, are they... they don't get any reimbursement for supporting? They just like doing it and they don't... ok?

(P) well, we'll get to that. That's one of the... was one of the hard things because some places didn't want to do it and you know, then... anyway...

(I) ok well, perhaps we'll touch on that a bit a bit later because we will be looking at the downside. So, do you recruit people with radiographic backgrounds?

(P) yes.

(I) and what's the sort of split between the ones that haven't got a radiographic background in terms of numbers? I mean, if you said you take twelve a year, approximately?

(P) ... maybe... a third sometimes. I mean, you know...

(I) a third are RT's?

(P) over three years right, we've had... well, the first year we didn't have any RT's but then we had four last year and this year... well, maybe not because this year I don't have any. So, we have a curriculum just for RT's, it's called the two plus two, so we give them a block of credits for completing their associates degree and passing the registry and then, depending on what electives they've taken in that programme, they could potentially come in as a junior.

(I) ok and that means they would... where would they start the programme then?

(P) in the third...

(I) in the third year?

(P) yes.

(I) and what selection criteria do you have? You just mentioned giving credits to RT's but in terms of you said about they have to have certain scores don't they?

(P) they have to have a 2.7 GPA, 2.7 out of 4. ACT's, we don't do, we don't look at the ACT's so much unless their incoming freshman and then, to get into the university they have to have 2.0 I think but to get in our programme, they still have to have a 2.7 and a minimum on the 22 on the ACT's.

(I) and that's all quite academic stuff isn't it. I mean, do you interview them for example?

(P) every student. Everybody... anybody that's interested or if a freshman is coming in and they have shown an interest or they want to pick we interview every student. So, we know all our students, you know especially by the time they get to the senior year, the fourth year because we mentor them as well as they have their academic advisor and then we mentor them as well. So, we're mentoring at least once each Semester and any time in between they want to come and chat to us but we interview all of them, perspectives or whatever, tell them about it... we let them job shadow because we don't want them to get to the fourth year and get out in the clinic and go oops!

(I) they don't like it?

(P) no. So, we don't want that. So, we have places that will let us send the students out to job shadow so they can see what's going on.

(P) so, we don't want that, so we have places that will let us send the students out to job shadow so they can see what's going on. When they apply, they have to have letters of recommendation, three letters of recommendation and then, they have to write a letter of why...

(I) they want to do it?

(P) yes.

(I) so, do you feel that you get a good sense whether they'll be good with patients in that interview process?

(P) I do...

(I) you do?

(P) I do... but it's not just that when they go out and do the job shadow, then they come back and we talk to them and you... and if they come out... you might want to say something different, you know we're very frank with them and ok, there's patient care, you know so you're going to have blood and guts, they're going to be puking and pooping and then you know and there's a body we're going to be you know, so are these things that bother you, you might want to do the technical side of it you know, IT or you know, go into if you really like MRI do a service engineer type role.

(I) so, how many applicants do you get for your twelve that you take roughly?

(P) well, we are new, we've had quite a few applicants. Some of them just... I don't know, I don't know why they, you know they'll go somewhere else or they want to do something else but we've had... so far, if they want MR they get in it because we haven't met our max yet, this is our third year of classes, so we have eight traditional students and one that's a Master's that does ours and you know the Master's work as well. So, we don't have twelve. Right now our total I think is twenty three with all...

(I) with everything great. I'm just sort of trying, you know you said that some people, you know that they're not going to... might want to do something else, I'm just trying to get a feel for how many that is I suppose. I mean, we're talking one or two, the odd person?

(P) the ones that we've talked to... we've lost a couple... you know, they get into the sciences and they just stay and you know, one left and went to English... she came in as a freshman and she wanted to do MRI because she had one...

(I) ok right!

(P) she starts doing a science and Jesus you know but she did really well writing and you know, so she you know, went on a different tack...

(I) to something else?

(P) right but we had a couple, they start squirming when you're talking about patient care and you...

(I) it's not for you? So, that's very good background and so do any of the applicants already have a degree?

(P) yes.

(I) and is that important for them to have it... does it make any difference to the academically more comfortable if they've got a degree or would you not notice any difference?

(P) Liz, one of our first students... well, Jim as well... Jim, you know he had a degree in nuclear medicine, so he had the patient care so he was very comfortable with everything. Liz had a marketing degree but if they have a bachelor's degree, we have a second bachelor's degree programme right but they have to have had like anatomy and pathology and physics we require physics because MRI physics to get into that. You know, there are some classes like medical ethics you know, when they have a general bachelor's degree like in marketing, they have to have a few of the science and maths before they can do their second bachelor's degree here, not if already if they have a science degree and they have those prerequisites, then they can come in and do the professional year and get a second bachelor's degree. So but they have to have had those prerequisites.

(I) so, it doesn't really make... I mean, you'll take them but it doesn't make it any easier or less... more or less difficult than somebody who comes in without a previous degree?

(P) if it's a science degree, you know I think they have a little bit of bonum? and maybe just their study habits, so they do better academically and that's not much, you know not...

(I) on the clinical side?

(P) because they have their study habits down and those kinds of things.

(I) that makes sense really and I'm guessing the next question I'm going to know, how important is it that the student has previously got a degree in diagnostic Radiography? I mean, you take some people who are already radiographers? Do they do any better?

(P) no.

(I) no, that's the main thing you know because obviously then, that doesn't make a difference.

(P) right, MRI is very different. They will do better when they get out in the clinic. They are a little more comfortable speaking with the patients ok... but no.

(I) no ok and generally, what are your views on the standard of education that just generally RT's get? I mean because you've probably told me but if you could sort of précis it? Your sort of general feeling out there about what it's... how it's going and what it's like?

(P) right well, they haven't even been... their not required to get even an associates right now correct? I believe that has not changed. Now, that's changing, you can get your associates and some of them will go on to get their Bachelor's but they're not even required to get an associates because they can go through an RT programme, take a test and their good to go because they have their certification exam, you know that certification and I don't agree with that. I think minimally they should have an associate's degree. I mean, their trained professionals and the responsibility that they have and we don't want button pushers there either. It is coming where students need their bachelor's degree, I think that's a good idea. I think they should at least have a bachelor's degree. Anybody who is out there, especially working with patient care and ok, radiation you know, should know because they... I mean, you see all these accidents with CT, did you hear about that bad accident with CT?

(I) yes, I have heard of that.

(P) you know and that just scared the living daylights out of me. I think they just... you know, it's evolving when it first started what are you going to do right?

(I) and in terms of sort of doing MRI though, you know so we've had conversations, not in this interview about it but tech's that were doing MR generally, what is your sort of experience in terms of their level of knowledge?

(P) as far as the x-ray tech's or...?

(I) x-ray tech's doing MRI?

(P) coming in and doing MR?

(I) who are just doing it now, you know out there in the hospital?

(P) and I worked with quite a few of those people and their knowledge is not where it should be and we've had the things I told you about, the girl who had her in upside down near the orientation but we've had... I mean, they are button pushers and I don't think that's a good idea. There's a huge safety issues plus, you know MRI's are expensive. So this patient is paying for this you know, three, four thousand dollar study and it maybe sub-optimal because the technologist is not knowledgeable. You know and you have a knowledgeable technologist, you're going to save that institution money because you can get what you need first time, you're not calling patients back, so your patients anxiety? has increased too. You know, we had a tech who... they hired her because she had three years of experience, so they hired her, she worked on a mobile what you have set things, you click your button right? So, I'm watching her image and I told you we do the Sagittal T1 to begin with and it was, I didn't even know, five or six minutes long... what are you doing? Like, I needed a couple of extra slices. Ok... so she was just adding the slices so it was doubling her scan time because she could only fit so many slices on it so I said, you know you can raise your TR twenty five milliseconds and you get your slices and they cost you about two seconds you know? Oh!

(I) and she didn't know that?

(P) she did not know that but that's what I'm saying. That is the difference between... and she was an RT that they trained on the mobile, just do this, this is what you cover, this is what you hit, have no idea what their changing and that's how things happen that you get really bad pictures, they think something's wrong with the equipment... it's them and that's another thing because you have the service engineers, you know if you have a problem and there were five tech's where I used to work. Two of us had our degrees, the other ones didn't and they were... I mean, we can get them around and some of them didn't even want to know, there was one who wanted to learn it like... the radiologist and the service engineers would not even talk to the other three and if they call in and say there's a problem, they'd say let me talk to... you know? So, then we're going... you know and they know we've checked things out, then they'll come in or they'll say, well you can do and they'd tell us what to do on the phone to check if it's you know? So, you save the institution on that that as well. You know, there is so many sides of it that is why they really need that bachelor's degree, they need the knowledge and that's you know and I think, you know hospital clinics would get that.

(I) exactly, that's where some of the advantages are isn't it? I mean, I think lots of advantages to it...

(P) me too!

(I) now, the next couple of questions are just something I'm just asking everybody because when I was doing my literature review for this research, it became very apparent that there are different definitions of what the term specialist means and what specialist practice means because in imaging we use the term specialist imaging modality and there's a sort of thought... well, I think because of that, there's been this notion that if you are somebody who works in those modalities, you are somehow an expert and your somehow more advanced than somebody who just does barium enemas for example, ok and there's this kind of snobbery and kind of... you know, I'm an advanced practitioner, whereas you know, in some ways MRI is just an ultrasound for example, which would be called specialist are actually just totally different rather than being specialist. So, I'm asking in different stakeholders really what their views are on this because it is really the generalist versus the specialist debate that affects all of this ok. So, first of all, what would you consider a specialist imaging modality?

(P) I would say they had special training in that modality.

(I) ok, so that, yes...

(P) or delegated training. I mean, it's no different to a specialist for a physician or a neurologist you know or orthopaedist, those kinds of things.

(I) ok and so do you think that specialism in Radiography is related to working in a modality like CT or MR or ultrasound or nuclear medicine or is it about the amount of responsibility or advanced knowledge somebody has? The sort of words that came up were, is it unusual practice or is it unusually superior practice that makes you be called a specialist in something?

(P) I don't know if it would be... I don't know if I'd chose those words. I would say they would have additional training.

(I) ok but you used the word additional?

(P) additional training.

(I) you see but your students don't have additional training?

(P) but you're talking about radiology.

(I) I'm talking about you know... I mean, traditionally ok if it's interesting that you used that word additional.

(P) but you were talking about radiology.

(I) I'm talking about Radiography ok? So, the tech's here, you know the tech's we've been testing don't necessarily have any additional training do they?

(P) well, they may have done training...

(I) but not formal, so they aren't taking their knowledge and advancing it really are they? I mean, they haven't had... I mean, I don't want to put words into your mouth...

(P) they have the training on the job. That's right and they study because they can pass that silly examination right but ok, they have had additional training. The level of that additional training is questionable at best...

(I) but it is additional on top of...?

(P) well, it has to be because they don't teach them that in the Radiography programmes. So, they wouldn't know what they were doing, so they do have additional... but the level right and the... what is the word I'm looking for, that level of their training, you know can be bear minimum to be able to run.

(I) yes ok. Well, your students haven't anything additional, they're learning that's just different from what the RT's learn when they were learning whatever they learnt in the past.

(P) but they still have additional because they have their bachelor's degree. So they have that bachelor's degree that's behind that, it is a rounded education and they do have more training than an RT does, it's learning it on the job.

(I) right, yes.

(P) right because they have the coursework being behind them. I mean, besides the traditional bachelor's degree they have seventeen credit hours right of MR coursework and then over thirteen hundred hours of clinical just for MRI and we have them come in the spring semester for that emerging class to tell them about ultrasound, CT, PET, PET MR, all those things and NMR which is really kind of fun, I go to see NMR because it's not making any noises.

(I) yes but I mean, the fact that you, you know you've developed this programme and you can not be an RT to do it means that you would see MRI as just something you don't need all the background radiographic knowledge to then add on to, it is a different area of practice.

(P) exactly...right...there is no ionising radiation. It is totally different and when I started an MRI and they wanted the nuclear medicine tech's to learn that MR not Radiography, in angiography or anybody like that because for one we had our degrees but it was our computer exposure because... there's a lot of computer in nuclear medicine and then the processing. I mean, there's just a lot of computer. So, that's why they wanted us to be in MR because there isn't a lot of computer, especially in the beginning when I'm right and remember calculating everything you know, you couldn't pick anything, you had to calculate everything to get your coverage and all of that.

(I) so yes, well you know, it's just interesting different sort of perspectives because it does... that is really key actually when your developing what level of education to put something at. Is it an advancement of previous knowledge because if it is then that's Master's really because you learn something at Bachelor's and you advance that into higher academic things at Master's level. Whereas, if it's just different then it fits more into a Bachelor's or associate degree category you know and that's you know, something because I teach Master's in MRI, everybody in the UK has to learn this at Master's level because everybody's got a Bachelor's in Radiography. There isn't any... and my problem is, is that people are trying to hit that Master's level academically whilst learning something completely different to what they learnt when they did their Bachelor's... they didn't learn MR in their Bachelor's Radiography programme or not to any great extent and so, a lot of them don't do well because their trying to hit Master's, learning something new that's difficult all in a really short period of time and so you know, one of the things... you know, there are different kinds of categories of knowledge and competency that fit with certain levels of education and if MRI is something that is different, not advancing radiographic knowledge then it fits in Bachelor's, whereas if it is taking diagnostic Radiography and advancing it to a higher expert level, then it fits better with Master's and that's why it's key to figure that out you know and you know, it seems ultrasound is seen as something different, so why isn't MR seen as something different and I think some people do see it as something different and some people traditionally say no, you've got to be a radiographer and then you become an expert in MRI and it's to do with attitudes and how you thought about something which is why I'm asking it really.

(P) , you know, I was never an RT and they say you were never an RT... you don't need to be, I don't need to be but I had a training in nuclear medicine and it's the patient care, you know we ended up in radiology right because it's a diagnostic imaging modality and you know it's got no ionising radiation but that's why we, I know and then the radiologists are used to reading, right looking at body images right, so now their specially trained in MR, so that's why we ended up in there because of diagnostic imaging because you will get our diagnostic and every other modality in radiology and there is no comparison. There is absolutely no comparison. So, I believe we can build off of an RT's training or degree's or whatever it is right but I don't believe you have to but I do believe they do need more education, that's why they need that Bachelor's degree to become an MRI technologist, a valuable MRI technologist. So, how many years do they go for their Bachelor's degree?

(I) four.

(P) Four, so it is...

(I) three or four really depending on the university. So, it's three years for a Bachelor's, it's four for a Bachelor's with honours, ok? So it's BSc hons. As opposed to Bsc but you cannot be a radiographer and registered in the UK unless you have a Bachelor's...

P) wow!

(I) there's nothing else available and that's been... that changed in about 1990 it changed...

(P) wow!

(I) and you know, as a result Master's in MRI came out in '95 because that was a natural progression but it's not necessarily...

(P) right but they didn't have their additional training?

(I) yes and I've been running that course since then and I'll tell you it's not necessarily the best way, it's one of the reasons I'm doing this research actually. So, I think you've answered the next one. Do you think that someone working in specialist imaging modality is a more advanced practitioner than somebody who's a generalist?

(P) I think they've had more training but you can question what that training is that their trained to be a button pusher or if their trained to understand... you know, you don't know that but they have had more training or they wouldn't be able to do that other...

(I) do that?

(P) right but the quality of that training is... you know?

(I) is questionable ...it's not just the quantity is it? Ok, so what do you think the benefits are to a department for employing somebody who's done a dedicated degree in MR? Yes, let's not worry about whether they are RT's or not. Let's just say their dedicated, focused in MRI. What do you think are the benefits to a department are to employ somebody like that?

(P) ok well, we hit on some of those... right, the safety issues with the MRI. Knowing... knowing the background, knowing how to change your protocols to get you what you need, you know the view. I mean, helping the radiologist. I mean, if your seen, you see the abnormalities, you can... you know what you need to get through that, to give them extra pictures of what's going to be beneficial, you know call back time, call back for the patients is decreased and like I said, if there's something wrong you know, if something happens where the magnet or the equipment you know, somebody who has been trained is more knowledgeable can get through that, save your downtime, save the call in from the service engineer... I just... all the way around they are more responsible and I hate to say it that way but they are and they know and you know, the button pusher... I mean, they can save you time just in your imaging like doubling the scan time because they didn't know you can, you know just add a little bit...

(I) and that's money here, time is money!

(P) when they say they want your scanner to be working so many hours of the day to be able to get reimbursed for it and then you have all this downtime because you don't know what they're doing or they put them in and they don't know what coil to use and their putting on the wrong coil and they're not getting pictures and their messing with the patient and sometimes when imaging is the same they're doing the wrong sequences or they change something and it's not right and they don't know what their changing and then you end up with twenty two sequences and you don't have a diagnostic image, ok so now the patient quits. So, you have nothing. So, you have to spend an hour with that patient and the magnet, you're not going to get paid a dime because the patient quit and you don't have anything diagnostic, you know and I mean, that's common, that's common. I don't know how many times we'd have the Tech, one of our evening tech's and she would do something and the patient would quit and she wouldn't have any images and we'd bring them down and have to redo them. So, I mean it's a money saver. One it's huge plus their more professional, I think they will add more to the department you know? They will get into more things that can promote that can promote facility...

(I) ok, what sort of things? What sort of...?

(P) research you know?

(I) research ok...

(P) education, you know MRI as I said, MRI safety was very important to me, so I asked to go and talk to the police department, the fire department, every department in the hospital, go to staff meetings you know, to educate everybody about this magnet, right everybody in the department and I don't believe... I think that's from that higher education...

(I) yes ok...

(P) you look more than and just doing this and just doing the scan, get the patient on the table, get the scan and go. You know, they just... you know, I just think they think of more things and what can I do, I'm looking for things to add to and you know?

(I) and also I guess. I mean, they probably don't need any training or much less training. You know, somebody graduates from your programme presumably can just hit the ground running when they get a job?

(P) right...

(I) they don't need to be anything additional by the department who's employed them?

(P) right, the only additional is to get you know first in that department's...

(I) yes, culture or...

(P) right, you know and how they do things, right. A lot of our students are hired by the clinical sites because then they know, I mean since they've spent time there, they not only know... they know what they're doing but they fit with the department or not, which is really nice if places would do that, you'd have a much happier working environment you know because you are working in this little control room and if you can't get along with the person beside you, it's miserable... been there, did not like it. You know, so they know that person fits in their culture, which you're pulling somebody off in an interview, you don't know...

(I) no, no and so, here in this city I guess because there's so many scanners, people are getting jobs a lot in departments where they've trained haven't they? (P) all of our students....

(I) so and that is perhaps not going to be reflected in other places where perhaps there are fewer scanners and people may have to go out somewhere? (P) well, we've had those too.

(I) we have ok? (P) we have a student at the Kansas City at a Paediatric hospital, they love him, we have one that's up in Chicago and they were hiring per diem and their full time. So, we have another one who's in an outpatient facility that we don't rotate two.

(I) not just it's... (P) yeah right ...and they like them. We are just sending out a six month employee satisfaction survey from previous, so we'll see what the employers say...

(I) that will be interesting. (P) but that's one of our goals so we can see...

(I) how you're doing, so it will be useful feedback for you actually want it because it may be also that there are some things missing possibly? (P) we'll see if their lacking in some area we have seen, we've already changed, this is our third year we have already changed. They said they are really timid talking with the patients. Ok, the first year, two of our students were NM Techs's and Liz was you know, you know but she said they have troubles. So, we employed more role playing, you know and we actually go right and talk to them you know. Ok, if a patient says can I see the pictures, no... well, why not you know right? You know because then they... you know and I'm not saying they will remember that because there are things we teach them and they go, well that would have been nice to know and around the clinic it's like, we did tell you, look at this lecture and then they'll regret it you know?

(I) but you know, that's not going to be any different from a RT student who's just graduated. They're not going to be ofay with patients either you know, so you can't really compare a newly graduated you know, MR student to a Tech who has been doing the job for several years in terms of patient communication. It's not fair to do that but if you remember this person has just graduated, just like a RT has, how much would they know? Not very much about that really would they?

(P) well and there are different exams. There are some exams they are not going to be exposed to because they're just not. You know, you can't do everything in nine months.

(I) no exactly. So, looking at the sort of drawbacks of only employing somebody who can only do MRI and nothing else, have you come across any problems in terms that they can only do an MR scan? You know, is there any resistance because they can't be pulled out to do chest x-rays or something? (P) I don't know. In a smaller hospital, I can see where it would be nice to have somebody that does x-rays and MR. We had, you know we had several x-ray technologists that we trained in MRI and you would think, you know if you have to clear somebody for foreign body, right you have to do Waters view that the technologist, that's an x-ray technologist who can just go back and take that picture because your waiting for them to get to the patient right and they don't. They don't because their MR . Their only going to X-rays right now.

(I) ok right but they don't do it anyway. (P) it doesn't really work that way but in a small facility I can see where they might have an advantage to do x-ray and MR and you know, if things... the job market would get limited. You know, their looking at people that are multi-modality trained right? So but we you know, if we have the RT's that come in with their associates and then they have their Master's, so then their trained properly, I would say you know, both in both modalities. So I can see where it would have its advantages but I don't think... and now there ARRT's coming up saying you have to be trained in that modality to be able to practice in that modality period. So, you know I don't know. You know, I was in nuclear medicine and once I hit MR, I never went back to nuclear medicine.

(I) no, no I think it just depends on the sort of, yes the department I think and you know, one of the things... I mean obviously, the foreign body issue is a possibility of a problem but would there be a way in the curriculum to put being able to do that you know, if you are not a tech and you come in, you are doing your Bachelor's. Do you think there's room where you could perhaps put in the curriculum where they could just learn how to do that for Water's View? (P) well, see there's the problem when their a button pusher with the water view and to be able to take x-rays you have to have radiation protection and you know, all the classes on radioactive material, so it's not just... I mean, you know then your teaching them to go in and hit the button for the Waters view and patient positioning and you know, they... you know, we learn anatomy, you have your basic anatomy and physiology class for your Bachelor's and then we have anatomy and pathology just for MRI. What x-ray has its forte for what they image you know, I can have a look at an x-ray and go, you know unless it's something that's really... you know and people look at our images, you know x-ray tech's and they go yeah you know...

(I) so, you don't know whether that... (P) I think it would fit in to the curriculum because there is much more to... than learning to be able to take that x-ray.

(I) so, that's , you know that's just something to consider you know and I think it's very much how different hospitals work as to whether this would be potentially a big problem of being very limited, you know as a manager if your going to hire somebody, you know because of I guess traditionally they hire a tech who can potentially do anything their asked to do, even if they never are, they like to know well, I could ask them to come out and do bariums that afternoon if somebody was off sick. Not that I necessarily would but I could you know?

(P) right, some people have that mind-set but I do think that shifting like Chuck Davis who likes the education, he's all about education he thinks you know, that they need the education. So and that will offer different things than somebody trained in x-ray and but we can do, you know we can go off of that, you know we can offer that but if their just trained in MRI, they'll have their Bachelor's degree's and that bachelor's degree is going to open doors. An associates will not.

(I) will not do. (P) so, you know, where I came from, one of the directors of the department had a bachelor's degree and that's it you know? So...

(I) yeah, ok. Ok, so the next question was just about any professional benefits of being focused on a particular role? I mean, I'm sort of thinking things like job satisfaction, you know if you are doing one particular thing and you're really good at it, does that make you more happy in your work than if you are somebody who can do lots of different things? (P) well it did me...

(I) ok yeah... (P) and you know why? I didn't have my formal training in MRI until I came here but I did it on my own you know and I studied for that task but and to know the system. I mean and you go to training you know but then to study it and I knew I knew it and I knew you know, the radiologists could say I went to a meeting and I got this, can you give me this and I know how to get him that and for me that's huge satisfaction that I know that thing and I can do and can do and mess with and get what they want I mean, you know but I love MR. I mean, I like nuclear medicine too but I love MR and I have and I've been doing it for thirty years and I still look at the pictures and go, oh yes and the stuff that we can do now, you know and you think people that are trained in MRI and what we are exposing them to, you know we're doing functional and we're doing all of that here. So, they get exposed to that and see the things you know for somebody who hasn't had that training in MRI, they're not going to be able to do those extra things, the new... the new...

(I) stuff which is exciting... (P) coming up yeah, they're not and I know you know, when we were getting new things, new capabilities right, they would teach the two of us right and the other three didn't want anything to do with that and their sitting there with that application specialist that you guys just sit on and you can show us how to do it later but they didn't even care to know how it worked. Now, I want to know how it works, what it's doing, what I'm doing.

(I) so it's probably an individual thing in some ways. I mean, some people might like variation possibly you know... (P) I'd agree with that...

(I) this is a question I'm asking a few people, you know and you know, I'm getting a mixture of answers. It seems to be... well, for me I like this. So, it's kind of a personal thing... (P) and I agree with that.

(I) and that I guess, I'm not surprised by that. If you just compare... we're nearly at the end now... if we just compare your students who are tech's first, compared to your students who are not, is there any difference in their attitudes to learning? Is any one group you know, more keen learners than the other group or...? (P) I don't think so. I think that just depends on the student because we've had, you know we've had those Radiography students and some of them were not very good didactically but their fabulous out there with the patients and they can get... they struggle with their classes but they got... I mean, they worked hard and they are here right, they wanted to go through that extra to have that bachelor's degree...

(I) the motivation obviously of both are the same, you know both groups want to learn extra stuff...

(P) and the didactic capabilities I think you'll have that. I mean, we have it with the traditional students as well. Some people some people struggle and some don't but the RT's that are coming to our programme want to do it and they want that extra, they want the Bachelor's, they want to advance you know whether you know, the Bachelor's and gain the modality on top of it.

(I) but clinically are the RT's better when they do the clinical component or not?

(P) they have a little head start at the beginning because they are more comfortable talking with the patients.

(I) ok...

(P) but that's about it.

(I) but that's about it, in terms of how they clinical how competent they are on the scanner makes no difference?

(P) no.

(I) ok and what percentage of your students get a job immediately after graduating?

(P) all of them.

(I) all of them?

(P) all of them.

(I) there is no difference then between the radiographers versus the non-radiographers?

(P) no.

(I) ok right and are there any sort of registration or employment problems at all with the non-RT people getting jobs. Obviously not here?

(P) no.

(I) no, it would be interesting to see...

(P) well they all take... they all sit for the registry, they've all passed the registry. There we are seven or nine percent... I had either seven or nine percent are seven or nine points higher than the national average. Our average, in the first year it was a lot higher than that because I already got my ninety's but then you have bigger classes and are more of a range but... I forgot what I was going to tell you...

(I) Alright, that's ok and do you think... do you envisage that maybe because you've got this Bachelor's now as a sort of an entry-level whether it's more likely that your graduates are going to go on to higher academic things like a Master's or PhD and do you think having because they've done the Bachelor's in MR, that's made because their more likely to do that than perhaps if it you know, the RT's who don't bother?

(P) some of them are...again, I think that's just on the person, you know because we have RT's where I worked previously, some of them want to go on and get their Bachelor's. So, their getting in other things, you know they may not want a bachelor's of Science then some people just want that higher education...so and some people... you know RT is a good job, you know you think ok, I've got two years I'm going to make decent money, you know I'm pretty marketable and comfortable, so I think it's just the...

(I) ... person... I think, you know if somebody's done the Bachelor's and they've got that sort of academic thing going, then perhaps more like... and you said you know that their much more perhaps to think wider about research and education because they've got that sort of basis already. So, you know if the opportunities come for them to do doctorates or Master's later, then perhaps...

(P) well and that's our Master's programme and that's been... you know, we have seven since we had one in our first year, four the second and we had two this year, so I'm not sure what's coming down the chute but six of those seven have all been in MR, you know because they want MR as their modality and they have something else as their Bachelor's.

(I) and so, they... just to be clear about that Master's component, when they... they don't do the Bachelor's and then decide to do the Master's do they?

(P) they can.

(I) they can but are they deciding at the beginning, I want to do a Master's or are they...?

(P) ...yeah, they can't be in the Master's... you have to have your Bachelor's first, so they can't... now our first year we had one who has his Bachelor's and he was in the Master's programme and it's a rigorous because you can't do the same thing for the Bachelor's as you do for the Master's. So, there are the extra classes and he said but no, you know so we let him back down to a Bachelor's because it's our first year and that whole mess I don't want to do that again. So, you pick a Bachelor's or you pick a Master's and if you pick your Master's and you can't do it, then you can wait until the next fall and go back to a Bachelor's because that was messy.

(I) so it is slightly different to how we do it in the UK you know. Everybody has to do Master's because they've already got a Bachelor's. So, you wouldn't chose one or the other because it's not open to them to do that. So, ok final question. Just this is a scoring one really in terms of how supportive you are of this introducing a degree in MRI to non RT's where one is not supportive, ten is totally supportive.

(P) well, I'm a ten.

(I) you'd be a ten! Yes, I sort of guessed that really. So, that was very interesting really because to get that sort of academic perspective is important and you know, one of the things I've found, there are so many different ways of getting into this which we don't have in the UK, it's all very standardised you know and it's like you can... just being an RT, you don't even have to have an associate degree here. So, some people don't have it, some have an associate, some people have a Bachelor's and it's just everybody's coming and doing the same job but their entry education is actually could be three different things from what I can tell and why do you think that standardisation isn't there? I mean, in the UK it's Government driven, it's basically you know, the Department of Health said right, everybody has got to come in and in the UK diagnostic Radiography is called a protected title and what that means is that... well, essentially it is because we are dealing with ionising radiation which is dangerous... it's for public health basically but anybody who is ionising people falls under this protected title and has to be registered...

(P) Because why they want that specific training ...

(I) ...yes exactly...

(P) Which I think is essential, you know it has always bugged me. You know, it has always bugged me that they can go through a Radiography programme and...

(I) ... not do it. You know, the problem though, I mean this is the sort of fall out for us trying to introduce a Bachelor's in MRI is it won't be registerable because the Privy Council, which is like the House of Lords in the UK decides who is registered, this body called the HCPC registers allied health professionals and in terms of imaging, it's only a BSc in diagnostic or therapeutic Radiography. They are not able to register anybody else and so from the point of view of you know, ok we want to do this from an educational point of view and from a patient perspective because you know, it's better for the patient and it's safer for the patient, it's virtually... how do you change that because it's the House of Lords that has decided and you know, in Australia for example because we can stop now but in Australia they have a BSc in ultrasound ok which they've introduced maybe three years ago and they have the same issue with it being protected and non registerable and in fact, the ultra-sonographers of Australia have got together and set up their own registering body as something separate... if you won't do it, we will and that's how they've done it.(

(P) and does that work for them? (

(I) it does work for them.

(P) that's wonderful.

(I) now, you see I can't see that working in the UK because it would require all the MR technologists to get together and say, we want to register, you know and I can't see that happening. So, I think it's going, in terms of my research and my recommendations you know, I think you know I've sort of said in my proposal that if educationally this works out to be the best thing, we have to find a way around those professional registration problems because it's more important that the patient's safe than it is for all these political barriers and everything that's going on over here in the professional side of things.

(P) ok you know back... you know you don't need x-ray to be in MRI technologist. So, if you look at the safety issues and it went right out the door... I don't know what I was going to say... golly, does it do that to you?

(I) yes.

(I) my God... oh, what was I going to say? Oh my God!

(I) it's that mag-lag again, listen to me... but it is different, MRI is not dangerous in terms of ionised radiation, it's very dangerous in other ways.

(P) I mean and not just MR safety. I mean, you know what about quenching you know implants and you know. I liked your question about if they did a patient yesterday and they haven't had an injury since then, can you do them today? I wouldn't, there is no way. You know... well, we won't get into that but...

(I) you know, obviously but this is very interesting, you know trying to apply thinking about how you do things here isn't going to apply in the UK in any way whatsoever because it would...well, what I'm proposing possibly you know is your eighteen when you come out of high school, you decide just like... in Nursing now, you choose I want to be a midwife don't you? So, you do a Bachelor's in Midwifery. You don't do a whole Nursing degree and then learn Midwifery after that, well you don't in the UK anyway. You know, if you want to be a Radiography or you decide you want to be therapeutic or I want to be diagnostic and there's like a common year where you learn everything and this is what I'm thinking is the way to go is to have a common year for everybody, diagnostic radiographer, therapeutic, MR, ultrasound, nuclear medicine...

(P) things that are common, in any of those?

(I) yes, like patient care...

(P) biology?



(I) biology, human anatomy, all of those things, ethics, terminology all of that and then after the common year, you specialise for at least two years. I think MR needs at least two years ok and then you get a bachelor's degree in diagnostic Radiography in therapeutic, ultrasound, in MR, in nuclear medicine but you've had the common year you see where you all learn the same things because there are commonalities and then you specialise. That's what they do in Nursing in the UK. You have a common year and then you say I want to be an adult nurse, I want to be a paediatric nurse, a mental nurse, a midwife and I think the other one is like community, health like school nurse and that type of thing and then you get a degree in that Midwifery, adult Nursing, mental nurse... they only do those things if you are a qualified mental health person, then you could only do mental health Nursing but that to me seems to be a good model actually but it does mean you can only do that you know?

(P) but can you go back to school and do it again?

(I) yes, you could go back and do a top up. So, you could go back and say well, actually want to do paediatrics as well now, so you maybe do an extra year or something or two years.

(P) because you have...

(I) you've got the basics, exactly don't need to do that...

(P) that's the way to do that, it's just like ok...

(I) I'll stop this now...

(P) so, you know MRI, as a Master's degree programme. So... [END].

TRANSCRIPT: COR.

(I) = INTERVIEWER.  
(P) = PARTICIPANT.

(I) Start recording there just so we've got a...

(P) what date have you got, is it the 11<sup>th</sup>?

(I) it is 11th December today.

(P) how quickly this year has gone.

(I) I know it has definitely. So you'll get... I'll take a picture of that and you'll get to keep that.

(P) ok thank you.

(I) right, so well thank you for agreeing to take part.

(P) I'm very happy to help if I can.

(I) that's great. Can I just sort of first ask what your role is in the society?

(P) so I... my job title is director of professional policy and that is to oversee the work, the professional educational work within the organisation to support the strategy which is set by our UK council and our UK council are elected members of the profession. So, they agree our strategy which is set on a three to five year rolling programme and we are just in the process of reviewing our strategy for the next five years. So, my role is really to operationalise what they've set as their policy.

(I) and so do you have any influence on that policy?

(P) yeah, I think I do and clearly we take part in the strategy discussions and we bring our intelligence I suppose a bit like civil servants to bear at the table. So, we're the ones who are doing the work day-to-day, our council members are coming in and out from their day jobs to bring that expertise into the organisation, the perspective from the members because we are a membership organisation and a charity, but I have that day-to-day intelligence about the profession, about the changing contacts, new policies, you know that whole world out there, myself and the team members of which I have at the moment nine radiographers working in our team who cover each of the breadth of the profession as much as we can because we are... the profession is expanding and the scope of practice is expanding. So, we've got officers obviously in MR, cross-sectional imaging... managers, some of them double up, we've got research, education, radiotherapy, clinical imaging, general policy. So, a whole team of people but their all registered radiographers just as myself to bring that expertise to bear on influencing the development of that strategy.

(I) ok right. So, the first thing that I've been asking people because it's something that came out of the literature is there seems to be a huge variation in how people define the words specialist, specialist practice and specialism. Not just in Radiography but in other healthcare professional sort of areas. So, I just want to explore that if possible? In Radiography we have this specialist imaging modality. Now, what do you think that sort of means in the context of Radiography?

(P) well, I have a bit of a challenge with that terminology because I think what's specialist one day is not going to specialist... not the next day but in two years. So, what we're doing now becomes the routine and when does that specialism then turn just to the routine practice. So, I find that quite challenging. I know in imaging we have, this is general Radiography, this is MR, this is CT, this is specialist areas of practice ultrasound etcetera all specialist but actually, some of that becomes a routine part of the core role of the professional of the radiographer. So, I very much find that word challenging because it's something that is on a moving spectrum.

(I) and I think it's historical actually in a way because I think that's where the confusion is sort of comes from to be honest with you because we've used that term specialist imaging modality for as long as I've been a radiographer, you know?

(P) I think... this might be off on a little tangent but you'll tell me if it's not... we have that term specialist radiographer as well, which actually doesn't really exist in our vocabulary now within this... within the society and college because we have you know the career progression framework, which spans obviously from helper, assistant practitioner at the unregistered level to practitioner advanced and consultant, accepting of course there is research managers, educators who are all integral to that. So, I think it's always been a challenge moving from that term specialist radiographer into our career progression framework and I know we have quite a lot of discussion when we were last revising our career progression framework about where does... you know, specialist is that the level between a practitioner and an advanced practitioner? Is it the novice, advanced practitioner? So, I think there's something around how terminology can confuse and conflict with what actually is now our routine core role and then, there are areas that become very narrow and actually you probably need someone with a very narrow scope of practice who's hugely expert in that area... I'm sure that...? not good but you know what I'm saying?

(I) yes, oh yes.

(P) so, you've got this big pool coming down to smaller, coming down to a small niche probably for some very, very specialised procedures.

(I) yes and I mean, this is what is coming out really but it's very important for my research because what the scope of practice that we're expecting is obviously related to education that we supply to make them that type of practitioner. So, just sort of following on from that, do you think that specialism in Radiography is related to the working in a focused area or is it actually to do with the responsibility... level of responsibility that somebody has?

(P) for me, it should be about the level of responsibility because you could be a specialist or an advanced practitioner in an area where you might think that's a small area of practice or it could be in a very general area where actually you are covering a wider sort of part of the pathway. So, I sort of see... I sort of see both really I guess. I'm not sure whether I have answered that ...

(I) the words that I've sort of coined when I've been thinking about this is, is practice in somewhere like MRI, which is focused, is it unusual or is it unusually superior? Is it different or is it an advancement of prior knowledge?

(P) if you took MRI, a bit like CT perhaps... I think what's important... I'm probably going back a step so tell me to be quiet... for me, we have developed ... a college development, a very broad spectrum education and career framework with learning outcomes, which enable the education providers to deliver programmes to meet that changing service need. So, they're not rigid, they don't say actually a third... two thirds of the programme should be general Radiography, a fifth should be this and a fifth... it can't be like that because we know services are changing. What we need is to present a series of options, which enable innovation at the education level but that has to be driven by the service and I think one of the challenges is that length between service and education and I think I'm not sure whether the service have that dialogue effectively enough.

(I) no, I don't think they do from my experience. I think there is definitely not enough dialogue between us the academics who provide... you know, provide the people for the service and the end user as it were.

(P) so, for example if we took the ultrasound discussion... we produced as you know probably, a position paper about direct-entry to train as ultrasonographers. We know this is quite a challenge because ultrasonographers have always seen themselves as advanced practitioners and actually, they may well be for the role that their doing but actually, are we saying is there a role for a practitioner level. So, having just come back from BMAS, lots of people standing up saying actually we do need to commission, we need... you know, clearly we need to grow that workforce, patients need it. So, actually, if you were an educational commissioner, you've got your pot of money, you need a solution. So, we all need to work together to work to that solution but what I'm hearing is nobody is willing to sit down and define what those different... well, somebody is because I've spoken to them now but actually we know we've got people doing ultrasound who are assistant practitioners in the triple A programme. Very narrow scope, very specific and they're doing it under supervision but it's done by them... we know we need advanced practitioners because it's a hugely complex area, I wouldn't doubt that but what can be done at this level. Does it always have to be Master's and so, the service need those people but they need to articulate. What is it that they need to see in that practitioner so the education provider can deliver those outcomes and I

think that dialogue needs to happen. So, I suppose why I'm saying this is, is because when I look back across the whole of Radiography and there was that light bulb moment that with one manager I was speaking to where she's knew... the proportion of MR, CT etcetera is growing, we still need general radiographers skills but it's growing and we need that crossover between the different modalities because we believe that someone needs that core knowledge at the bottom but the proportion of MR their getting is not enough. So, I said well, do you speak to your education provider? Do you have that dialogue because actually that ratio, we don't set in stone what the ratios should be? So, anyway that was helpful because I think it identified, no we didn't but I suppose what I think is, at the moment I think our college believe actually that the core skills as a radiographer are across here and getting that proportion of different modalities and different pathways within there is absolutely essential.. but then because some of those areas require additional skills, you will then often require a postgraduate qualification to develop those skills to a higher level and perhaps within a narrow scope or perhaps a whole pathway, so I'm thinking of a consultant practitioner who may cover a cross-section of imaging for example and maybe across disciplines.

(I) I think what I'm sort of discovering is that the undergraduate programme is way too overcrowded because they have to cover so much and so they do it all... apart from... you know, when I say that's a bit of a generalised statement but you can't possibly do MRI in ...as part of everything else and be able to be competent to practice it when you come out and this is one of the sort of I suppose one of my theories is that if you had said like we did with therapy or diagnostic Radiography, if you have a common first year and then you have two years in MR or ultrasound or whatever...

(P) having done both, I did diagnostic first then therapy actually and it was extremely helpful to me I have to say for my career.

(I) and that will be something that will probably come out in a minute really. So, first I just want to sort of talk about the plusses and minuses. If we just think about hypothetically if we had a direct-entry into MRI without the need to be a diagnostic radiographer, we've got people coming out with a BSc in MRI what do you think might be the benefits as a profession and the drawbacks to the profession?

(P) I mean, I think the benefits are that you are training for a very, very specific role. So, it will be a very narrow scope of practice. So, you could probably train that person in that modality to a higher level because that is their core focus and they will probably be able to go into the service and be more effective from day one but actually some of the drawbacks are that they might not understand the wider imaging modalities that exist out there to enable them to make informed decisions about actually, would it have been better if this person had a CT or would it have been better for this person had a plain x-ray for example or an ultrasound scan and so to me, there's something around those core areas which I think you need that knowledge across the spectrum. I also think it then limits the workforce to a very specific area. Also, they couldn't be regulated unless they were actually they were being called radiographers which again is that issue with safeguarding the public and again getting new names on the register, we know is not likely to happen. We have been fighting for a long time...

(I) is like is an issue actually. I mean, just to highlight themes I suppose from the possible benefits side of things which have come out from other interviews. There's things that have sort of floated to the surface about people having more job satisfaction when they can just focus on one thing and they get more out of it because they are experts and can focus on one thing and perhaps retention is better for the employer and perhaps better for the patient to have somebody who is perhaps safer and more competent in inverted commas. I mean, do you think those are valid or how do you feel about those?

(P) I don't know, it's very difficult to say because I'm not in that position but I think from our organisation's perspective, we obviously want to create careers that are meaningful and that do add value, are responsive to service need and are perhaps centred around the patient. So, I suppose it comes back to my earlier point that I would worry a little bit that perhaps it was too narrow a field because you'd lost that breadth of what was happening either side. Also, if you train in one area, actually then how easy is it to go back and then develop and be more flexible. I mean, if MR sort of went you know, I'm sure it's not but you know, in five or ten years there might be some other new I don't know 'x, y, z' and you've got to retrain that workforce again. So, there's something around those core principles for me and for this organisation I think at the moment that we believe is right.

(I) so, in the ultrasound argument, are they also part of the ultrasound argument?

(P) well, the challenge for ultrasound is we know there are professionals who enter ultrasound from many different routes and I think it's a slightly different issue because we know we can't attract enough... it's grown out of all propensity and so we need quite a urgent solution to that and because we have a lot of professionals who are not registered at the moment, there are various different bodies obviously involved in the discussion around the future ultrasound workforce and so I think it has to be something we work at together with those bodies whereas a lot of the other areas are areas that we've traditionally been within a... scope.

(I) yes ok, again it's a sort of historical thing because you have so many different types of practitioners already involved in ultrasound whereas at the moment in MR that is less so... much more focused?

(P) absolutely.

(I) do you think this might have an impact on sort of CPD in terms of you know the whole educational structure is now geared around any learning that takes place post Radiography has to be at master's level and this is something very dear to my heart because I teach master's level and I'll tell you, the majority of people struggle massively with learning what is essentially a new subject because they haven't really learnt it before at the same time as having to attain those master's skills?

(P) I'm sure there is a need for succession between the bachelor level and the master's level and not everybody is immediately going to go to that level, particularly in certain areas because particularly in MR I guess there's lots of physics around that and I know the complexity of the delivery of MR has changed tremendously and there are these huge... the energy of the magnets is really increasing isn't it?

(I) yes...

(P) I was reading something about one that they were testing, I don't know if it was in Germany, a huge number of Tesla for research purposes. So, I think it needs to be a progression and some of it will... clearly we want people to get to master's level, we want people to be working at advanced practitioner level delivering and changing practice for patients so at a consultant level but there needs to be a spectrum.

(I) yes, which I don't think is there at the moment...

(P) interesting.

(I) you know, well I know it does from my own experience you know, it's a big problem because it's such a big jump you know, as they haven't learnt it properly at undergraduate level...

(P) and is that because though that the... I mean, you make reference to the fact that there's so much to cover in the programme or is it that the breadth that the HEI's could probably look differently at how they delivered that programme?

(I) yes, I think we are quite limited because we cannot assume that somebody has the knowledge and their basically topping up. If somebody's coming to do an MSc in Radiography, then obviously the curriculum is designed for them to advance, develop knowledge they previously have but most of the students that we get, although they might be scanning, they don't actually know very much and I know that's quite a sweeping statement but even people who have done twenty five years in MR... I mean, I've had a student a few weeks ago admit to me he's been a radiographer for six years, he said to me I actually don't know any anatomy and so that is possibly you know, he's just started the course...

(P) and that to me begs the question about individuals as well taking responsibility for their own education, their own CPD and not doing things where they feel they're not competent to do it as a registered professional. I think the diversity and the scope of the practice of the Radiography profession has changed immensely and I would like to think the education is delivering what the service needs and I think from what you've just said perhaps it's not but I do see the opportunity for different ways of learning and I think that really needs to... I'm not saying it's not there but I'm thinking for example, you know the eLearning for healthcare programmes, we've got a huge number of MRI modules there, which are in the process... I think many are finished, all available free to the NHS and so they are a really good step to learning some of these principals...

(I) absolutely, absolutely...

(P) that should be embedded...

(I) and that's you know I think actually knowing about those and being able to offer those is important so that when we get them to start the course they've already got ... they've you know, done something...

(P) a big promotional as Dorothy Keane's coming to work with us for two days a week until at least August and we're going to do more and more promotion and we're still trying to finish that off... free, free!

(I) right, not... I just want to talk about registration now ok? Now, how important ... I suppose I know the answer to this but I'll ask it anyway, how important to the society would it be for an MR practitioner to be registered with the HCPC?

(P) I think it's important for professionals to be registered with the HCPC...

(I) ok and so you would say that an assistant practitioner who are not registrable at the moment, where do they sit? Are they not professionals in...?

(P) we have a voluntary register, so we have had to adapt and develop a certain mechanism for that and clearly the assistant practitioners work under the supervision direct or indirect of a registered practitioner and that is their level of practice and I would never ever see them and we wouldn't go higher, although it's often mooted that actually they can do this, they can work at a higher level, actually not because that's the registered level. So, we are strong believers and support registration.

(I) and I think... I mean, registration at the moment as I understand it has come through because of the protected title in ionising radiation and having to protect the public. That's why that registration came in years and years and years ago, is that correct?

(P) I would look at it that actually doctors and nurses are registered, dentists are registered... all the other allied health professionals that work in the health service are registered, so it's not to do with the ionising radiation per se, it's to do with professional practice.

(I) and ok, turning that around a little bit, if an MRI practitioner has a BSc in MRI and is practicing as a professional, should they not be able to be registered by the HCPC?

(P) ... I wouldn't see a problem with them being registered. The problem is in the logistics of getting any more professions on to the register and actually, MRI I see as part of the core role of the radiographer, so why would... and it is within our domain as we've mentioned before, I don't see the HCPC looking to register a small part of that section of that profession that exists already whereas ultrasound is slightly different because of the reason because of the breadth of the professionals who've actually started to use that technology or are using those technologies...

(I) because in Australia, they've got round this the registration of ultrasonographers by the Australian society actually setting up their own registering body because they felt it's important to be registered and I personally support that and you know, if there is a problem or a difficulty in getting the HCPC to recognise it then why shouldn't we be doing the same?

(P) so we have a voluntary register for sonographers and anyone who's practicing as a sonographer is welcome, it is a voluntary register, it's not a legal requirement and we have that set up so that really we are then offering some protection to the public but actually as a Professional Body, it's almost at odds with protecting the public because we're protecting our members. So, it's not the best mechanism but it's the only mechanism at the moment. So, ideally you need it to be separate from the Professional Body.

(I) right ok.

(P) and the CPSM, if you look back to the CPSM you'll know this, was very much how they operated was very jointly with each of the professions and I can remember the joint validation committee's which were joint responsibilities and we would go out jointly to validate programmes... well, that responsibility was shared let's say whereas it's not now they are totally separate and they need to be to protect the public. So, the voluntary register is there, we know there's no obligation for people to join, I couldn't quote the numbers on it over one hundred, one hundred and eighty or something and every year, every two years I think, we review that register and review those on it but the obligations are not the same, the legal obligations are not the same.

(I) yes and I think from my perspective should my research show actually educationally this is really important thing to do then I would be arguing, well we've got to find our way through these barriers to registration somehow, it seems silly not to implement something that is better for the public let's just say if that is how it turns out to be because...

(P) but how do you demonstrate that's it is better for the public though isn't it and the patients? How do you demonstrate through this work that it is going to be...? I don't know the answer to that, I can only present our view but... you know, it is, you have to find ways around things, it's actually the barriers in the way have prevented... I mean, a bit like the ultrasound, if the barrier's there you've got to work to find that solution without a doubt.

(I) you'd think the society would support trying to find a way through if they could be convinced that this was a good thing to do in other specialities not just in ultrasound?

(P) I don't know the answer to that. I'd have to ask our council because our view at the moment is very much that Radiography encompasses MRI, encompasses CT, provides the core underpinning for ultrasound as well. So, many of the programmes that their still looking at for ultrasound, which might be direct-entry maybe three plus one. So, there still coming through the Radiography route but giving that one year of super extenuated skills. So, that could be another way through for this as well, it could be a three plus one for MR and CT

(I) that's some way you know, that is down the line. You know, finding ways so that it works and we can make it happen is important, so...

(P) I think there's something around and I think this is the view of our organisation is around that core body of knowledge that actually enables you across diagnostics to have that view and you're not just in that narrow sphere... clearly it's very expert practice in here and to do some of those weighted images... I think I was at the Homerton recently and you know we have got the applications person again to teach us a little bit more about... don't quote the Homerton but it was very interesting and a very useful visit there and they've actually got you know, radiographers reporting in lots of different areas but in MR, in CT, in ultrasound and plain film and chest x-rays. So, really empowering model they've got there.

(I) and that's nobody would have thought that would have happened ten years ago?

(P) no, it's fantastic.

(I) this is why it's great isn't it you know? So, final question. Having discussed all of this... I just want to get a sort of numerical score on a scale of one to ten, where one is not at all supportive and ten is completely supportive... how supportive are you of this idea of direct entrance?

(P) I can't... it's really difficult for me to answer that to be honest Catherine because I'm not here presenting my view, I'm presenting the view of council and the view of council at the moment is that MR is part of the core role of the radiographer...

(I) right.

(P) is that ok?

(I) no, that's absolutely fine. No, that's great. I mean, it's given me you, a real sort of insight into really and it's what I anticipated, it's the sort of barriers to you know, that should all the data point towards we need to think about this, you know actually where they are doing it in other countries what would be the problems of starting here and it's important to know those.

(P) I think as well, other countries certainly Australia have you know, quite comparable workforce models to ours and the training but if I look across Europe you know, I've recently come from the European Federation of Radiographers societies and the variation... everyone is supposed to be at the EQF benchmark six as you all know and the variation there is absolutely immense and the scope of practice of those individuals is often at an assistant level with the doctor standing over them but a lot of those countries are making quite good progress in getting to that EQF benchmark six.

(I) well that's... I mean, this is what started this all off, I did the big European wide research project where I objectively tested a whole range of MR radiographers from all over Europe including the UK and it's the same test I'm going to use in America and it was quite shocking actually that nobody, even people who have been doing MR for fifteen years got more than four out of ten.

(P) do you think that that the people that might have been doing it for fifteen years, did not have that underpinning? Do you have confidence that obviously technology and IT, everything has moved on. When I started training, MR hadn't even come in and it was CT and I was recounting to the Education Researchers the other week that was on the first brain it wasn't the first brain scan but it was the first of the first brain scanners at the Maudsley. You know, you'd remember this, it would take an hour to do a brain scan chunk, chunk, chunk.

(I) there's lots of variables but actually one person I've seen who was an application, an MR application specialist that didn't know, they were one of the lowest scorers and so this is and I know because I teach all over the world and I know there's a massive variation in how people are trained but their all being let loose on the public basically.

(P) but they have different levels of... some of them supervision within that don't them?

(I) they do.

(P) America they can't do calculations in radiotherapy there but...

(I) it is, it's a different scope of practice but you know, scary things do happen unfortunately and I think you know, my remit was really I need to just look at... is it right there is a huge variation? Is there a better way of doing it or come up with something completely different. So, anyway thank you very much.

(P) no, it's good, thank you.

(I) and... [END]

## APPENDIX 8: Undergraduate MRI curriculum

Magnetic Resonance Curriculum American Society of Radiologic Technologists, the Association of Educators in Imaging and Radiologic Sciences and the Section for Magnetic Resonance Technologists of the International Society for Magnetic Resonance in Medicine. 2008	
Clinical Practice and Patient Management	Code of ethics/professional behaviour Patient assessment, education and care Infection Control Medical Emergencies Clinical Competency: Head and neck, Spine, Thorax, Abdomen and pelvis, Musculoskeletal, Special imaging procedures, Quality control
Computers in Imaging and Medical Informatics	Computer Fundamentals Computer Components Computer Operations Radiology Applications Quality Assurance and Post-processing Computer Advancements for Imaging
Ethics and Law in the Imaging Sciences	Ethics and Ethical Behaviour Ethical Issues in Health Care Legal Issues Patient Consent
Fundamentals of Imaging Science and Health Care	The Health Science Professions The Health Care Environment Hospital Organization Radiology Organization Accreditation Professional Credentialing Professional Development and Advancement
General Education	Communications Mathematical/Logical Reasoning Arts and Humanities Information Systems Social/Behaviorial Sciences
MR Imaging Procedures	Imaging Considerations Imaging Planes Signal Characteristics MRI safety and screening considerations Routine MR Procedures Specific Studies Contrast Studies Patient Education
MR Parameters, Imaging Options and Quality Assurance	MR Imaging Parameter and Sequence Selections Imaging Options Quality Assurance
MR Pathology	Central Nervous System, Head and Neck, Thorax, Abdomen, Pelvis, Musculoskeletal, General Vascular Disorders.
MR Instrumentation and Imaging	Magnetism Magnets Shim Systems

	Radio frequency Systems Gradient Systems Computer Systems Operational Flow
MR Pulse Sequences, Image Formation and Image Contrast	Intrinsic Contrast Characteristics Extrinsic Contrast Characteristics Pulse Sequences Image Contrast Characteristics MR Contrast Media MR Image Formation Post-processing
MR Safety	Static Magnetic Field Radio Frequency (RF) Magnetic Field Patient and Personnel Safety Screening in MR Gradient Magnetic Fields Equipment Safety Screening in MR Environment Emergencies in the MR Environment Safety in MR Contrast Administration
Pharmacology and Drug Administration	Drug Nomenclature General Pharmacologic Principles Five Rights of Drug Safety Drug Categories of Relevance to MR Classification of Contrast Agents Routes of Drug Administration Intravenous Drug Therapy
Physical Principles of Magnetic Resonance Imaging	Nuclear Magnetism MR Signal Production MR Signal Induction/Sampling/Conversion MR Image Contrast Characteristics Introduction to MR Image Formation Imaging Planes K-Space and Image Formation
Sectional Anatomy	Head, Spine, Soft Tissue, Neck, Thorax, Abdomen, Pelvis, Upper Extremity, Lower Extremity