A focussed ethnographic study of Diagnostic Radiographer problem solving in the trauma setting

Mrs Ann Marie Newton-Hughes

DProf Health and Social Care

University of Salford

School of Nursing, Midwifery and Social Care

2015

Word count 40554

Contents

Figures, tables and images

Figures

96

Tables

Images

Abstract

Aim

When imaging patients for x-ray examinations Diagnostic Radiographers should position the patient so that bones, joints and soft tissues can be clearly visualised. In order to achieve this a widely accepted set of positioning criteria have been developed for each anatomical region. In the trauma setting the radiographer must either move the injured body part sufficiently to meet the criteria or manipulate the imaging equipment to achieve a similar representation of the anatomy. This difference between the presenting position of the patient and the imaging position required presents the radiographer with an ill-defined problem which employs careful management to minimise patient discomfort, avoid risk of injury and optimise image quality for diagnosis. Little is known of radiographer problem solving in the clinical setting. This research uses focussed ethnography to investigate how the radiographer achieves appropriate positioning of the patient through the application of problem solving.

Method

A focussed ethnographic study was undertaken in the clinical setting at two hospital sites. Sixty three observations of trauma imaging examinations were undertaken followed by semi structured interviews with the practitioners. The data were analysed thematically following a structure recommended for focussed ethnography.

Results

The findings of this unique study demonstrated a multi-stage assessment process used to evaluate the patients' injury and ability to co-operate with the examination. In light of the assessment the conduct of the examination varied with the degree of complexity of the examination and a measure of this complexity was developed to illustrate this. Findings demonstrated that in agreement with known models of practice the level of cognition required moved from subconscious to conscious as the complexity of the examination increased it was also found that radiographers recognised the importance of experience in managing imaging examinations. Opportunities for re-design of the examination request card were also identified to aid communication between the referrer and the radiographer and assist in the radiographers' assessment of the patient. Areas for further research are also suggested.

Acknowledgements

Extension of my thanks need to start with my workplace and colleagues who have provided me with the funding, time and support necessary to allow me to complete this research. Particular thanks should be offered to my supervisors Leslie Robinson and Fred Murphy without whose support and encouragement I would still be procrastinating and without whose guidance I would be floundering.

Thanks should also be offered to the managers and staff at the Trust where the research was undertaken. I should extend my thanks for their time, the friendship they offered me and their patience during my observations and interviews.

I also need to express my thanks to my family who have supported me through the ups and downs of this research journey. I must apologies to my daughters for my absence from many of their social and sporting events, my vague replies when focussed on my studies and the time delay when inspiration struck and dinner was late. I must also recognise the support of my husband who undertook additional transport duties and listened to my “eureka moments” whenever they occurred (day or night!). Finally I should thank my mum for her unfailing faith in me.

Chapter 1: Introduction

Introduction to the research

Scant attention has been paid to the skills, knowledge and cognitive processes used when undertaking radiographic examinations. Education tends to focus on technical skills rather than some of the other skills required to conduct the examinations. Attention is paid to practical skills such as technique, patient care and communication but does not always consider other skills such as problem-solving. Problem solving is the cognitive examination of an issue or difficulty to identify solutions and select an appropriate option. Decision making is an integral part of this process to allow selection between the options presented when problem solving. Radiographers are required to solve problems and make many decisions when undertaking a radiographic examination as each patient will require adaptation to their individual needs and radiographers will need to choose between a range of options when positioning the patient and deciding whether the image produced is of suitable quality. While much is known of problem solving and decision making in other professions little is known about these processes when undertaken by radiographers. This unique project is intended to shed light upon this area of radiography practice by examining how radiographers problem solve when deciding how much to move a patient when positioning them for limb x-ray examinations following trauma.

This chapter will introduce the reader to the profession of radiography, and the role of the Diagnostic Radiographer, the research undertaken, and its rationale. The chapter discusses the need for the development of problem-solving and decision-making skills within the profession. It will go on to provide a brief overview of the concept of problem-solving and decision-making and relevant problem-solving models.

1.1. Research title

A focussed ethnographic study of Diagnostic Radiographer problem solving in the trauma setting.

1.2. Research aim

To develop an understanding of how radiographers problem solve when positioning a patient for appendicular trauma imaging.

1.3. Research objectives

1. To observe the problem-solving processes a Diagnostic Radiographer undertakes when examining a patient with traumatic appendicular injury.
2. To describe the clinical practise of radiographers in this scenario.
3. To explore problem-solving literature to develop an understanding of the models of the problem-solving that may be applied in this clinical scenario.
4. To identify any of the research findings which might be applied in education and practice.

1.4. The radiographer and problem solving

Radiographers are members of a legally recognised profession (Nixon 2001, Health Act 1999, HCPC, 2013) where the ability to practice radiography is limited to those who have undertaken specific approved education and gained appropriate qualifications. The Health Care Professions Council (2015) tells us **"**Diagnostic Radiographers produce and interpret high-quality images of the body to diagnose injuries and diseases". The Society of Radiographers (2015) provide a brief definition of the duties of a Diagnostic Radiographer in the UK as:

> "*Diagnostic Radiographers employ a range of different imaging techniques and sophisticated equipment to produce high quality images of an injury or disease. Diagnostic Radiographers will take the images and very often report on them so that the correct treatment can be given. They use a range of techniques including: X-rays, Ultrasound, Fluoroscopy, CT (computed tomography), MRI (magnetic resonance imaging), Nuclear Medicine, Angiography*"

The definitions of the radiographers' role provided by the professional bodies above give a succinct description of the functions of the radiographer but pay little attention to the skills required for this role and lacks a patient centred focus. Schön (1986) suggests that some professions focus on technical skills acquisition and this appears to be the case in

radiography. Diagnostic radiography developed as a profession under the direction of members of the medical profession (Price, 2001) and adopted the medical model (Laing, 1971) which treats the body as a mechanism rather than part of a more holistic person. This leads to a tendency to consider the patient in the context of what is wrong with them rather than as a person. Booth and Manning (2006) confirm this indicating that the medical model has been used as a base for radiography education in the past. The work of Whiting (2009) provides an insight into the thoughts of student radiographers who feel they are joining a profession where technical ability is prioritised over other aspects of care.

The range of imaging techniques employed by radiographers has developed significantly since the founding of medical radiographic imaging in 1896 just a month after x-rays were discovered by Roentgen (Spiegel, 1995), however the need for the radiographer to accurately position the patient for their imaging procedure remains unchanged irrespective of the imaging modality. In 1939 Clark published the first edition of her book "Positioning in Radiography". The book was highly influential and was utilised to standardise radiographic technique in hospitals. It has been used as a basis for radiographic positioning since its first publication. This is quite remarkable given the rate of change within the profession and the medical imaging technology. While the book provides details of how the patient should be positioned for radiographic imaging it does not provide advice on how the positioning should be achieved. Every radiographer working in imaging practice must position the patient appropriately to allow visualisation of the structures under investigation. The correct positioning of the patient has been identified but how to achieve the position is one of the first problems the radiographer encounters when conducting an examination yet this concept remains un-investigated.

The problem under investigation in this research is the difference between how the patient presents their injured body part and how they should be positioned for optimum imaging and diagnosis as illustrated below (image 1 and image 2). Image 1 illustrates the potential presentation of a patient with an injury to the upper limb and Image 2 provides an example of the positioning described in an early text but still employed today.

Image 1-Potential presenting position for an elbow examination

(http://www.videojug.com/film/how-to-make-an-arm-sling)

Image 2- Positioning of the arm for radiographic examination of the elbow.

Meschan, I. (1955). *An Atlas of Normal Radiographic Anatomy*: Saunders, London

The Department of Health has overall responsibility for the training of health care staff. Working with Health Education England they have developed the Education Outcomes Framework (DOH, 2013). The first indicator "Flexible Workforce" (Flexible Workforce-fw1a-d) proposes that health care staff should be able to act on initiative, decide on change and make service improvements, suggesting that staff should be able to problem solve and make reasoned decisions as part of this process. The College of Radiographers recognises that problem-solving and decision-making skills are a requirement for a qualified radiographer and includes both concepts in its educational requirements as part of its Education and Career Framework for the Radiography Workforce (COR, 2013). The Health Care Professions Council, in their Standards of Proficiency document (HCPC, 2013), say that radiographers are autonomous professionals who need to make reasoned decisions about their practice. Standards 4, 4.1, 4.2, 4.3, and 4.4 relate to problem solving and decision making in clinical practice (HCPC, 2013). They suggest that radiographers should be able to assess a

situation to decide its severity and draw on appropriate knowledge and skills to resolve the issue, to make reasoned decisions, demonstrate initiative and to accept responsibility for their decisions by demonstration of justification. The Career Progression Framework developed by the Society and College of Radiographers (SCOR, 2009) provides detailed information about the role of staff at all levels of practice. Employed at band 4 are staff in assistant practitioner roles undertaking some radiographic examinations. Their scope of practice is limited with little requirement for problem solving and decision making as assistant practitioners work under the guidance of radiographer practitioners at grades band 5 and above. At bands 5 and above there is clear scope for problem solving (figure 1).

Figure 1. Radiographer roles and problem solving/decision scope (Adapted from the SCoR Career Progression Framework, 2009)

Career Level	Band	Education	Descriptors	Decision scope/ types
Assistant Practitioner	4	NVQ Level III or equivalent	Specific task related skills supervised by registered practitioners An assistant practitioner performs non-complex, protocol-limited clinical tasks under the direction and supervision of a registered radiographer.	Limited scope of problem solving/decision making, works under the direction of a fully qualified radiographer. Cannot justify examinations Limited to non-complex examinations therefore no adaptation /problem solving required. Cannot accept or reject self generated images
Practitioner	5-6	BSc (Hons)	A practitioner in radiography autonomously performs a wide-ranging and complex clinical role; is accountable for his or her own actions and for the actions of those they direct. They undertake a wide range of both simple and complex imaging examinations or radiotherapy and oncology treatments on the full range of patient types and conditions and in a variety of settings.	Wide scope of problem solving/decision making: justification, positioning of complex examinations and patient groups, accept/reject self generated images and those of students, indicate abnormality or not, additional images required

Advanced Practitioner	7	Masters level education	An advanced practitioner, autonomous in clinical practice, defines the scope of practice of others and continuously develops clinical practice within a defined field. Advanced Practitioners work in a specific area of expert clinical practice and are involved in delivering specialist care to patients. They also contribute to the evidence base and the development of other staff, act as an expert resource for their particular field of practice and demonstrate team leadership	Wide scope of problem solving/decision making: including those for staff at band 5 or 6 in addition specialist knowledge in a particular area may allow decisions related to diagnosis, referral for further imaging, administration of contrast media
Consultant Practitioner	8	Masters and working / studying at doctorate level	A consultant practitioner provides clinical leadership within a specialism or area of service, bringing strategic direction, innovation and influence through practice, research and education, based on specialised knowledge and skills. Such roles will nominally comprise at least 50 per cent clinical work and significant work on research and development, audit, education and training of others, and policy and practice development.	Wide scope of problem solving/decision making: including those for staff at band 5, 6 and 7 in addition focussed specialist knowledge in a particular area will require management and leadership decision making driving the direction and development of the service.

Radiographers employed as practitioners at band 5 and above (figure 1) are required to make decisions and manage complex cases. Radiographers are required to make clinically reasoned decisions about many factors when conducting imaging examinations and thus display autonomy within elements of their practice. For example radiographers routinely decide whether to accept an image they have produced or discard it and re-image the patient. This decision is dependent upon whether the image is of diagnostic quality and requires careful consideration, as re-imaging the patient using x-rays will require further exposure to ionising radiation.

Radiographers are also often required to evaluate patient mobility in trauma radiography, where patient mobility may be reduced as a result of the trauma, and/or due to the patients' reluctance to move due to their pain and the potential to exacerbate the injury. Radiographers frequently ask patients to move painful injured limbs in order to achieve positions which the patient may otherwise be reluctant to attain. Strudwick (2011) tells us that radiographers will

always have to balance being caring with making physical demands on the patient in order to produce a diagnostic image.

Recent publications by radiographers in consultant roles at band 8 level (figure1) (Kelly et al., 2008, Ford, 2010) suggest that staff in these roles require support with the problem solving and decision making commensurate with their roles. This lack of support is unsurprising when it is evident that little consideration has been given to supporting problem solving in frequently encountered areas of routine radiographer practice.

Problem solving and decision making within a health care profession is clearly associated with accountability to the patient but a health care professional must also consider their accountability to their employer, their profession and society at large. As suggested by Crompton (1990) members of a profession are expected to behave in an ethical and altruistic manner by society at large. Thus, when making a decision the radiographer is influenced by many factors. The central ethical concern is a concern for others and the choice of action is based upon this.

Grundstein-Amando (1991) tells us that ethical decisions are made using our own moral standards but that these must be used in reference to the patient and the organisation in which the decision is made. Grundstein-Amando's (1991) discussion of an ethical decision is based around the concept of analytical decisions (structured and methodical decisions). It is clear from the literature that good decisions can be made using either analytical or intuitive models. However Benner (1984), indicates that intuitive problem-solving is a model frequently used by experienced practitioners in the clinical setting.

Sternberg (2003) discusses wisdom. He suggests that wisdom is related to intelligence but is more than this, wisdom implies working for the wider good rather than just for one's own ends. We can use intelligence to further one's own ends to the detriment of others but this is not wise. Wisdom furthers good for all. As a member of a profession a radiographer needs to consider what is wise for their patient, employer and profession. Barnard (1938) an eminent business man and renowned early founder of business theory suggests that the decisions a person within an organisation makes are not the same as their personal decisions.

It is evident then, that to work as an autonomous professional a radiographer must be able to make decisions which are considered to be, ethical, wise and in the best interest of all. However Andersson et al. (2008) tell us that it may be impossible for the radiographer to

produce a satisfactory image without compromising patient care and here the radiographer is faced with complex ethical decisions. Radiographers need to be provided with support to problem solve and make decisions as part of that process.

If radiographers are required to solve problems and make decisions, then they should be supported in the development of acquiring the skills needed to make these decisions. The need to teach problem-solving skills is in the guidance from the College of Radiographers (2013) but the need to teach decision-making skills as part of this process is not made explicit. Failure to prepare radiographers to problem solve and make clinical decisions may result in a reluctance to make decisions or perhaps make the wrong decisions. As mentioned previously in section 1.4., Whiting (2009) concluded that radiography students feel their studies emphasise technical skills over other skills. Whiting argues for the development of a more holistic practitioner who demonstrates the ethos of professionalism rather than a skills based technician. She favours the development of more diverse skills such as communication, team working, patient centred care and ethical practice. She acknowledges that this is taught but appears to be put aside in practice as preference is given to competence, speed and efficiency. Baird and Wells (2001) suggested that traditional approaches to teaching and learning do not help students make the links between facts and clinical problem solving. Whiting (2009) tells us that without the professional skills of critical judgement and reflection, decision making and self-regulation are compromised. It is clear therefore that work needs to be conducted in this area to help inform curricula and support professional development.

The development of problem-solving skills may be fostered in radiography programmes in a variety of ways, two examples of which are Problem Based Learning (Edwards, 2006, Kiguli-Malwadd et al., 2009, Robinson, Harris, Burton, 2015), and Action Learning Sets (Mackay, 2002). Problem Based Learning employs questions and scenarios to develop learning skills in educational programmes to foster problem framing and solving abilities. The students gain both knowledge and thinking skills as part of this process (Wood, 2003). Action Learning Sets (Pedler, 2011) typically take place in practice when students hold informal discussions about real life clinical practice situations and learn from sharing their experiences. While problem-solving skills are developed using these methods in some training programmes the process is not necessarily made explicit to the learners, failing to raise awareness of the problem-solving skills being developed and it is not clear how or if decision-making is taught as part of the problem-solving process.

1.5. A brief introduction to problem-solving theory

The Oxford Dictionary (http://www.oxforddictionaries.com/definition/english/problem) defines a problem as *"a matter or situation regarded as unwelcome or harmful and needing to be dealt with and overcome.....a thing that is difficult to achieve".* D'Zurilla, Nezu and Maydeu-Olivares (2004) tell us that a problem is a task or life situation which requires a response when no satisfactory solution is immediately evident. Problems are considered to be well defined or ill defined (Hardin, 2002). Ill-defined problems are complex and may have several solutions with well-defined problems having the opposite characteristics. Van Gundy (1981) presents a third class of problem encountered in the clinical setting: a semi structured problem. This type of problem sits between the other two types and will require a mixed skill set to resolve it (Makhathini, 1992). The difficulties encountered in practical problem solving are the novelty of the situation, the resources available, a potential lack of skills, ambiguity, and uncertainty (D'Zurilla, Nezu, Maydeu-Olivares, 2004). Huitt (1992) also tells us that there are recognised theoretical models of problem-solving. These will be discussed in more detail in the following chapter.

When a patient presents for an x-ray examination, following a limb injury, they may typically present with pain, guarding the injured area and holding it close to their body for protection. This project aims to explore how a radiographer manages the process of moving a patient's body part from a position of comfort (e.g. supported in a sling or by proximity to the body) to the position required to x-ray the limb. The difference between the two positions is the problem which needs to be solved. Huitt (1992) discusses the 'gap' between the goal and the 'current situation' and explains that problem solving is the process undertaken to understand the gap. In radiography the 'gap' which needs to be addressed is how much the radiographer should move the patient for an x-ray examination of the limb. Hardin's (2002) definition tells us that this could be considered a complex ill-defined problem which may have several solutions or may be considered a semi structured problem (Van Gundy, 1981).

1.6. Summary of the chapter

This chapter has introduced the profession of radiography, given a brief overview of the role of those who work within the profession and the recognised concomitant need for problem-solving skills. It has highlighted the fact that at all levels of practice radiographers solve problems and make complex decisions with no formal training in clinical problem solving. Radiographers have problem solved how best to position a patient for trauma examinations since the professions emergence in the 1920s (Price, 2001) and yet little is known of how they do this. It has also provided a brief introduction to problem-solving theory. This chapter has provided a rationale for this unique research.

Chapter 2: Literature review

2. Introduction

Having introduced the concepts to be examined in this research it is important to understand and contextualise what is already known of these subjects; the theory base, the application of the theories in the clinical setting and more specifically what is known of problem solving in the profession of radiography.

There is a wealth of literature related to problem solving and there are numerous theories and models of problem-solving many of which are unrelated to this research e.g. STRIPS, (artificial intelligence), (Fikes, & Nilsson, 1971), Crowdsourcing, (online group problem solving), (Brabham, 2008). There are thought to be two broad categories of problem solving: analytical and naturalistic (Dane & Prat, 2007). Analytical problem solving generally uses extended gathering of information to provide logical structured solutions to problems, frequently employing specially designed computer programmes to support the process. Naturalistic problem solving explores how decisions are made in real world settings (Klein & Klinger, 1991) without the aid of computer programmes. It is clear that computer aided analytical problem solving models cannot be applied in a time limited clinical setting, such as that found in diagnostic imaging.

In real world situations problem solving is also known as social problem solving (D'Zurrila & Nezu, 1982). In the social and health care setting more relevant models of problem solving can be identified e.g. The Nursing Process (Hurst, 1985, which employs a step by step linear guide to diagnosis, planning, treatment and evaluation (discussed further on P26).

The problems encountered by radiographers in the practice setting are dynamic and context based (Andersson et al., 2008, Ahonen, 2009) and do not follow normative principles. Literature related to problem-solving conducted 'in vivo' or 'real world' was therefore examined. Critical links were made between the current theories of problem-solving and their potential application in the radiography context explored. Evaluation of present day and past perspectives on problem-solving and its real life application in general clinical practice was also undertaken using some of the body of knowledge related to clinical problem-solving in nursing and physiotherapy. These professions were selected as together with the requirement to assess and triage patients before treatment in the acute setting in a similar manner to

radiographers they have a wealth of publications in this field identified through a search of the OVID database. OVID was selected for its access to a wide range of relevant health and social care data bases e.g. Medline, Evidence Based Medicine, CINAHL etc. The search revealed that health care professionals working in less similar settings (occupational therapists, midwives, dieticians and podiatrists) had fewer publications in this field. What is known of problem solving in radiography is therefore considered in light of what is known from nursing and physiotherapy research and particular attention is also paid to the methodologies employed in this research to gain an insight into radiographer problem solving. This chapter will conclude with a summary of the main points.

2.1. Problem-solving models

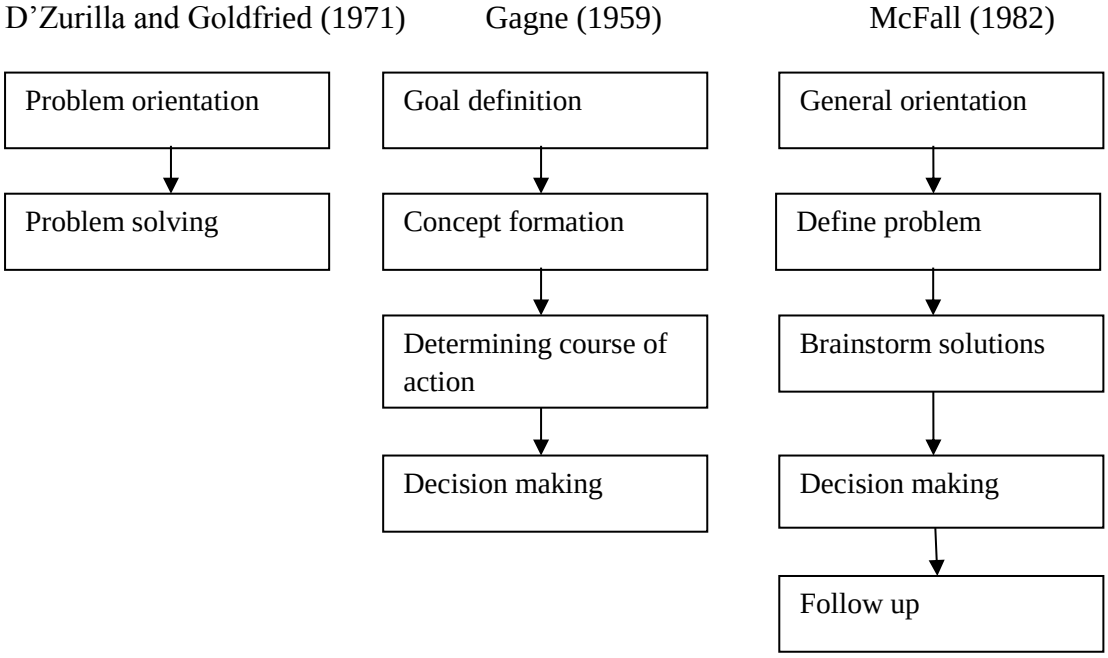
Research in real world (social) problem solving has taken two approaches. In Europe, researchers have worked to develop general real world problem-solving models (Broadbent, 1977, Dörner, 1975) while in America research has been undertaken to develop models specific to particular activities or disciplines. This has resulted in a wealth of problem-solving models, incorporating a series of steps or stages, some with specific tasks or purposes in mind and others which are designed to be applied generally in many settings. Problem-solving models related to specific tasks include mathematics (Temur, 2012), chess (Scurrah & Wagner, 1970) and game playing (Jørgensen, 2003). Although decision models exist to support clinicians in the specific task of deciding whether to request an imaging procedure (Stivaros et al., 2010) there are no problem-solving models developed specifically for the radiographic imaging process, therefore in order to understand the problem-solving process employed by radiographers general 'real world' models were considered.

2.2. Social general problem-solving models

Problem-solving models suggest a series of steps and different models propose different numbers of steps. Early four stage models of problem-solving include those described by Wallas (1926) and Gagne (1959) (Figure 2). The model proposed by Wallas included stages named "incubation" and "inspiration" where the creative solution to a problem appears suddenly in the mind after the mind has subconsciously considered the problem for some time. This theory was initially highly criticised by contemporaries who did not accept the notion of unconscious thought (Woodworth & Schlossberg, 1954) however the work is considered to be seminal in the understanding of creativity. In 1971 D'Zurilla and Goldfried

introduced a two stage model of social problem-solving (figure 2) with problem orientation and problem solving as its two steps in the process. D'Zurilla is a recognised expert within the field of social problem solving with a wealth of research experience in this area. McFall (1982) and Lieberman et al (1986) expanded upon the D'Zurilla and Goldfried model (1971) to develop five stage models. These models do not vary in content but subdivide some of the stages to introduce additional stages to the process. The figure (2) below illustrates the stages identified in three different models each describing different numbers of steps.

Figure 2. A comparison of 3 models of general social problem solving

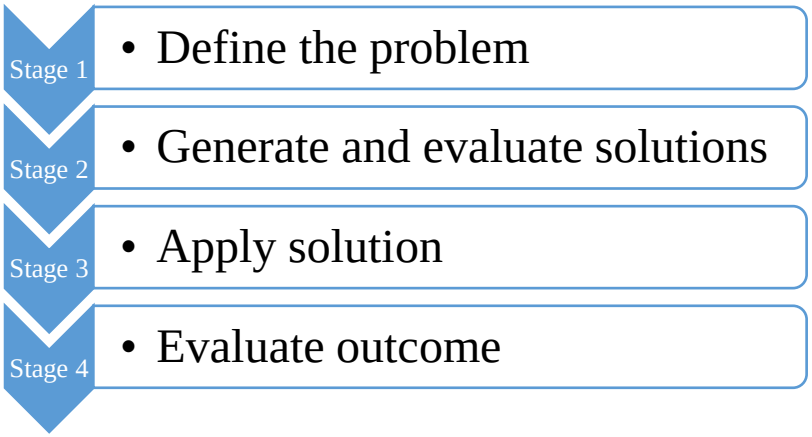


It can be seen that the initial step is similar across all models. D'Zurilla and Goldfried (1971) group several stages into one overarching "problem-solving stage" and that Gagne (1959) and McFall (1982) have similar models but McFall (1982) introduces a review phase to his model of the process in order to evaluate the solution for verification (Wallas, 1926), refinement, refuting (Dorfman, Shames, Kihlstrom, 1996) and learning (Meizrow, 1991). It should be noted that in their paper D'Zurilla and Goldfried (1971) identify four skills to be employed in the problem-solving stage of the model which include: problem definition, generation of potential solutions, decision-making and implementation with review. These four skills map well with the extended stages in the two other models and might have been included as separate steps within the model they proposed. It can be seen from the models

presented that problems are solved using similar steps but how the individual steps are presented and conducted may vary.

Newel and Simons' general problem-solving model (1972) (Figure 3) is similar to the models described above and for the purpose of this research the Newel and Simon model is the one which will be adopted to fully explore the concept of problem-solving. The model provides four well defined steps with clear explanations of the activities conducted during each step. Its selection is based on the general nature of the model, the simplicity of the language it employs, the transparent nature of the components of each step and the world wide recognition of the quality of this work. It is necessary to select a general model due to the lack of recognised clinical radiography problem-solving models. Simon received many awards for his work in computing and psychology and Newel received a Nobel Prize for his work in this area. Their model identifies the process steps as: define the problem, generate and evaluate solutions, apply solution and evaluate outcome.

Figure 3. General Problem-Solving Model (Newel and Simon, 1972)



Each step of the problem-solving process requires skills and knowledge and a review of the literature was conducted to identify the requirements of each step. These requirements are described in the following section and a summary of the theories related to each step is provided in figure 4 below.

2.2.1. Step 1: Defining the problem

Einstein is reputed to have said that if he had one hour to save the world he would spend *fifty-five minutes defining the problem and only five minutes finding the solution (*Couger, 1995*).*It is clear that without an appropriate understanding of the problem those hoping to solve it will be unsuccessful. Newel and Simon (1972) describe this as the 'problem space', which is the

problem solvers perception of the task and its context which allow the range of possible solutions to be considered. Problem framing is a similar concept which brings the problem into focus (Rothman, 1997). It is generally considered (Rothman, 1997), that the steps involved in defining the problem are: deciding what is known about the problem, identifying what is not known and then gathering information to address what is not known. The information is gathered using facts, inference, speculation, and opinion. Opinion is used when seeking advice from others.

In this research problem framing would require an evaluation of what is known about the patients' ability to move into the position required, the factors the radiographer does not know and some method of gathering as much information as possible to inform the gaps in knowledge. In a pressured dynamic clinical situation which requires action it is possible that the radiographer does not have the luxury of an extended time period in which to frame the problem but this is as yet unexplored.

2.2.2. Step 2: Generate and evaluate solutions

This step is complex and can employ many methods and tools and can be open to many influences.

Sternberg (1995) suggests that solutions employed in problem solving vary in relation to the knowledge and experience of the problem solver. As the stages demonstrate, problem solving requires cognitive skills (Jonassen, 2000) and it also employs underpinning knowledge (Hardin 2002). In problem solving there are two types of underpinning knowledge: declarative and procedural. Declarative knowledge concerns principles, concepts and facts (Rittle-Johnson & Koedinger, 2005). Procedural knowledge concerns the skills required (Bisanz & LeFevre, 1990) or knowing how to perform a task (Hardin 2002). In nursing practice Carper (1978) added two further dimensions of knowledge: aesthetic and ethical. Aesthetic knowledge is based in the context of the situation, the patient's individual needs and the entirety of the situation. Ethical knowledge includes moral dilemmas and choices. These additional types of knowing should be included in this consideration of problem solving as they reflect the complexity of the problem to be solved by the radiographer who will need to consider the context of the situation (aesthetic) and the balance between causing pain for the patient and gaining a diagnostic image (ethical).

While it is recognised that knowledge is required to solve problems it is also acknowledged that it is not possible to know everything about a problem and it is not possible to always identify a perfect solution. This is certainly the case when imaging for fractures as the problem solver cannot know the extent of the problem until at least one image is acquired. Simon (1986) noted that in 'real world' situations problem solvers and decision makers narrow down the range of choices available to make the process manageable and timely. Rather than seeking the 'best' course of action they settle for a satisfactory option.
The components of problem-solving knowledge arose from the development of three separate learning theories: behaviourist, cognitive and information processing (Hardin, 2002).

Behavioural problem-solving theorists suggest that problem solvers employ tools such as 'trial and error' and Hull's Response Hierarchy (Hardin 2002) which explains habitual responses to situations where the habitual response has proved satisfactory in the past. Appropriate habitual behaviour is positively reinforced by success in solving the problem, the more often the behaviour is effective the stronger the habit becomes and the more likely it is to be used in problem solving (Ormrod, 1987). Forming habits of this type and employing them can save significant amounts of time as trial and error need not be applied (Hull, 1934). Those interested in behavioural problem solving are concerned only with the observable elements of behaviour in this context (Hardin, 2002).

Cognitive problem solving uses heuristics, 'rules of thumb' can be developed to expedite the process. McPeck (1981) and DeRoos (1990) suggest that this narrowing of choices is done using heuristics, based on experience and trial and error. The term "common sense" is a heuristic applied to situations which appear clear cut. Common sense suggests that you should not walk in front of a moving vehicle, without having to recall previous experience of seeing or hearing about the damage that can be caused in a person's collision with a car. The application of a heuristic means that less time and effort is spent finding a solution. DeRoos (1990) goes on to tell us that employing an heuristic does not guarantee success and can lead to patterns of failure but this can be avoided by applying multiple heuristics to a given situation. Judgement heuristics are used when a deal of uncertainty accompanies the task with limited information. One form of judgement heuristics is similarity judgement where past experience of a similar problem is drawn upon to inform the current problem (Hardin, 2002). It could be argued that the behaviourist theory of habitual response is similar to judgement heuristics as it draws on past experience but the links between observed behaviour and the cognitive theorist approach is

not clear at this time, perhaps as a result of the different theoretical approaches espoused by researchers in this field. It may be that this is the same phenomenon explored from differing perspectives Availability heuristics relies upon the information which is easiest for the decision maker to retrieve from their memory, i.e. which solutions jump to mind (Schwarz et al., 1991). Another form of heuristic is the anchoring and adjustment heuristic (Epley & Gilovich, 2006). This occurs when a solution is formed (anchoring) and an additional source of information suggests that an adjustment should be made to the initial solution. This type of heuristic can introduce bias to the process (Epley & Gilovich, 2006) as the adjusted solution frequently remains similar to the original solution (Tversky & Kahneman, 1974). In radiography this might occur when more information is presented to the radiographer part way through an examination, for example the patient expresses pain when being positioned and the radiographer needs to adapt what they are doing based on this new information. The role and concept of heuristics in problem solving is not without criticism. Gigerenzer (1996) criticises the use of heuristics to explain irrational decision making on the grounds of failing to consider the context of the decision. For example most research in the area of irrational decision making has been based in laboratories and not real life settings, because of this Gigerenzer believes that it does not explain the process of heuristics and calls the theory '*vague*'. This stance has been successfully refuted by acknowledging the potential scope and generalisability of the heuristic research findings which explains why humans make irrational judgements rather than taking the normative, logical, structured approach adopted by Gigerenzer's field of study (Dunwoody, 2009).

In the 1970s cognitive psychologists began to develop the theory of automaticity which differentiated between effortless (automatic) and effortful (controlled) thought processes in problem solving. Tversky and Kahenman (1974) conducted early work in this area and Kahneman received a Nobel Prize for this seminal work. Automaticity or effortless thought processing is considered to have 4 elements:

- Inevitable evocation- A thought process is triggered without the awareness of the problem solver.
- Incorrigible completion – the thought process runs to its conclusion even if the problem solver becomes aware of it and attempts to stop it
- Efficient execution- the thought process requires no conscious effort on the part of the problem solver

- Parallel processing- the problem solver can focus on other thought processes as no effort is required to monitor the automatic thought processes. The only times when parallel processing cannot occur efficiently is when both processes require the same thought pathways in the brain

Kihlstrom, (2008)

Automaticity or effortless thought processes can be demonstrated when a subject is asked to read aloud words presented in print. When the words are colour names but the names are presented in a different colour e.g. black (MacLeod, 1991) the subjects are more likely to say the colour they see rather than the word printed. Automaticity is an accepted theory and research in this area is ongoing. The terms automaticity and intuition are sometimes used synonymously (Sanchez, 2012). Both these concepts draw on the tacit knowledge of the subject which Polanyi (1967) considers to be composed of "know how" and "experience based knowledge". Recent work has started to clarify the processes underpinning intuition (Salas et al 2010). Betsch (2008) has identified 3 stages in the intuitive process. In the first stage learning is stored in the long term memory. In the second stage the information is unconsciously recalled which results in the third stage which is a 'feeling' that is used to inform decision making. Dane and Pratt (2007) describe intuition as an emotional unconscious response. It can be seen that tacit knowledge is potentially part of the learning which is stored in the long term memory and informs intuitive problem solving.

The third learning theory, information processing theory, follows from cognitive psychology theories and makes the analogy that the mind is like a computer receiving data, storing data and then retrieving it for use (McLeod, 2008). Information processing is concerned with our capacity for memory storage (sensory working memory), how well organised memory storage is and how efficient retrieval is (Hardin, 2002). Sensory memory filters incoming information for important facts and is unconscious. Working memory encodes the filtered information, gives it meaning, links it to other information and sends it to the long term memory for storage and retrieval (Huitt, 2003). This stage of the information processing problem-solving process involves hypothesising potential solutions to the problem and drawing on long and short term memory to inform the process. The computer/brain analogy is plausible but fails to account for the parallel processing ability of the human brain (computers chiefly use serial processing, one piece of information after another). It also fails to acknowledge the effect of emotions and motivations which influence human thinking (McLeod, 2008). Information theory has led to research developing artificial intelligence.

Any one, or a combination of, these approaches can be used in the generation or evaluation of potential solutions to the problem and this research will need to consider all these elements when attempting to understand the behaviour of the radiographers.

It is at this point in step two of the Newel and Simon (1972) problem-solving model (generate and evaluate solutions) when solutions have been generated using the methods described above that a choice must be made between the potential solutions to the problem. The choice between the range of solutions generated is decision making.

Decision making is a term used in healthcare literature with some ambiguity. Simmonds (2010) suggests that it has a similar meaning to critical reasoning and clinical judgement. Extensive reviews of journals (including the Journal of Judgement and Decision Making) have failed to identify a clear differentiation between decisions and judgements. In this thesis decision-making is taken to be the process of selection between a range of options, in order to solve a problem and which results in an action. Some decisions are more complex than others, and not all decisions have a right or wrong outcome, since the value of the outcome will be defined by the perspective of those involved in the decision. In general terms there are two approaches to decision making, analytical and intuitive and there are a multitude of terms used to describe the alternate types (Salas et al., 2010). Most models of analytical decision-making require conscious cognitive input, time and preparation in order to inform the decision maker of the range of options available before a decision can be reached. The terms objective, analytical, rational and normative are all associated with this form of decision making and are used to describe models which follow a structured pathway. Objective normative decision making assumes that there is a best decision to be made and that a process of comparison and elimination will identify the best decision. Work in this area develops analytical systems for decision-making. This type of decision making lends itself to mathematical formulation and these models or systems can then be used to run computer based decision making programmes for their own end or to support people in their decision making. The alternative approach applies intuition. Dane and Pratt (2007) describe intuition as an emotional unconscious response. Intuition in this sense can be related to 'automaticity' described earlier where routine functions are performed without conscious thought e.g. experienced drivers changing gears when driving. In radiography practice this might equate with the automatic selection of an appropriately sized image receptor by a radiographer experienced in CR imaging. Betsch (2008) has identified 3 stages in the intuitive decision process. In the first stage learning is stored in the long term memory. In the second stage the

information is unconsciously recalled which results in the third phase, the generation of a 'feeling' that is used to inform decision making. These factors appear similar to the first stage of automaticity "inevitable evocation" described by Kihlstrom (2008). It is clear though that one must have prior experience or knowledge of the problem to have learned from it and stored it in the long term memory.

Unintended bias can predispose the decision-making behaviour of the problem-solver to select solutions to the problems in either conscious or subconscious problem solving. Bias in this context is not intended to suggest the introduction of inaccuracies or incorrect decisions but rather a tendency for a person to use one problem-solving method over another or to always solve problems in a similar manner. Examples of unintended bias include priming and anchoring. Priming occurs when information, experience, or other factors strongly influences the problem-solving approach (Kahneman, 2011). Priming has long been recognised for influencing outcomes, athletes use priming to improve performance (Todd et al., 2005), others use priming in situations where they are uncomfortable to help boost performance and control emotions, termed as "psyching myself up" (Senyshyn & O'Neill, 2001). It can be seen that priming may subconsciously influence behaviour in problem solving. Priming in problem solving can be as a result of environment, key words or concepts and beliefs (Kahneman, 2011). The brain automatically and unconsciously associates these factors with other knowledge and experiences which can bias problem solving. When completing word problems, experiments have shown that having been exposed to the word "eat" the solution to the word problem "s—p" is more likely to be answered as "soup" than "soap" (Kahneman, 2011). Recent work also suggests that movements can prime problem-solving behaviour, when the problem setter swings their arms the problem solvers frequently incorporate a swinging action to help solve the problem in engineering (Werner & Raab, 2013). Recognition primed decision-making (Klein, 1989) is a long established concept which identifies the influence of previous similar experience on behaviour. This work initially considered the work of fire officers in emergency situations where they drew on past experience to inform their actions in highly dangerous and time critical situations leading to the development of a model of behaviour. There are acknowledged limitations of this model, which relies upon the experience of the decision-makers and their ability to recognise their own misunderstanding of a situation. There are also criticisms of recognition primed decision-making research: further work needs to be done to develop research tools and methodologies to investigate the link between cognitive activity and problem solving and to

better demonstrate the validity of these concepts (Cannon-Bowers et al., 1996, Yates, 2001). Recognition primed decision-making has three possible elements the first being a simple "if this then" solution for situations the problem solver has encountered before. This element links closely with the concepts of intuition and automaticity and the problem solver may not be conscious of undertaking the decision process. The second element "if this is like this then" suggests that the solution is modelled to fit similar previous experiences. The third element "if this is like this then this might happen" models several scenarios and the problem solver picks from the most appropriate. All of these elements of the model are context based and are applied in a time pressured environment where the risk to health and property is high. Therefore when the problem solver selects between the options available it may not be the best option that is sought but the first option that presents an appropriate solution. This type of approach to problem solving recognises that there may be no best answer but that an appropriate answer is acceptable.

There are other forms of bias in problem solving (Myers, 1993) which are relevant to this research including confirmation bias. Here the problem solver looks for information which confirms what they believe. The representativeness heuristic is applied when people assume that they understand the situation because it is similar to something else, a form of stereotyping, (as with recognition primed decision making). If the situation is not similar and they ignore important information, or use useless information by allowing it to have significance in the problem when it does not, the application of the representative heuristic demonstrates bias towards the use of useless information in inappropriate situations.

2.2.3. Step 3: Apply solution

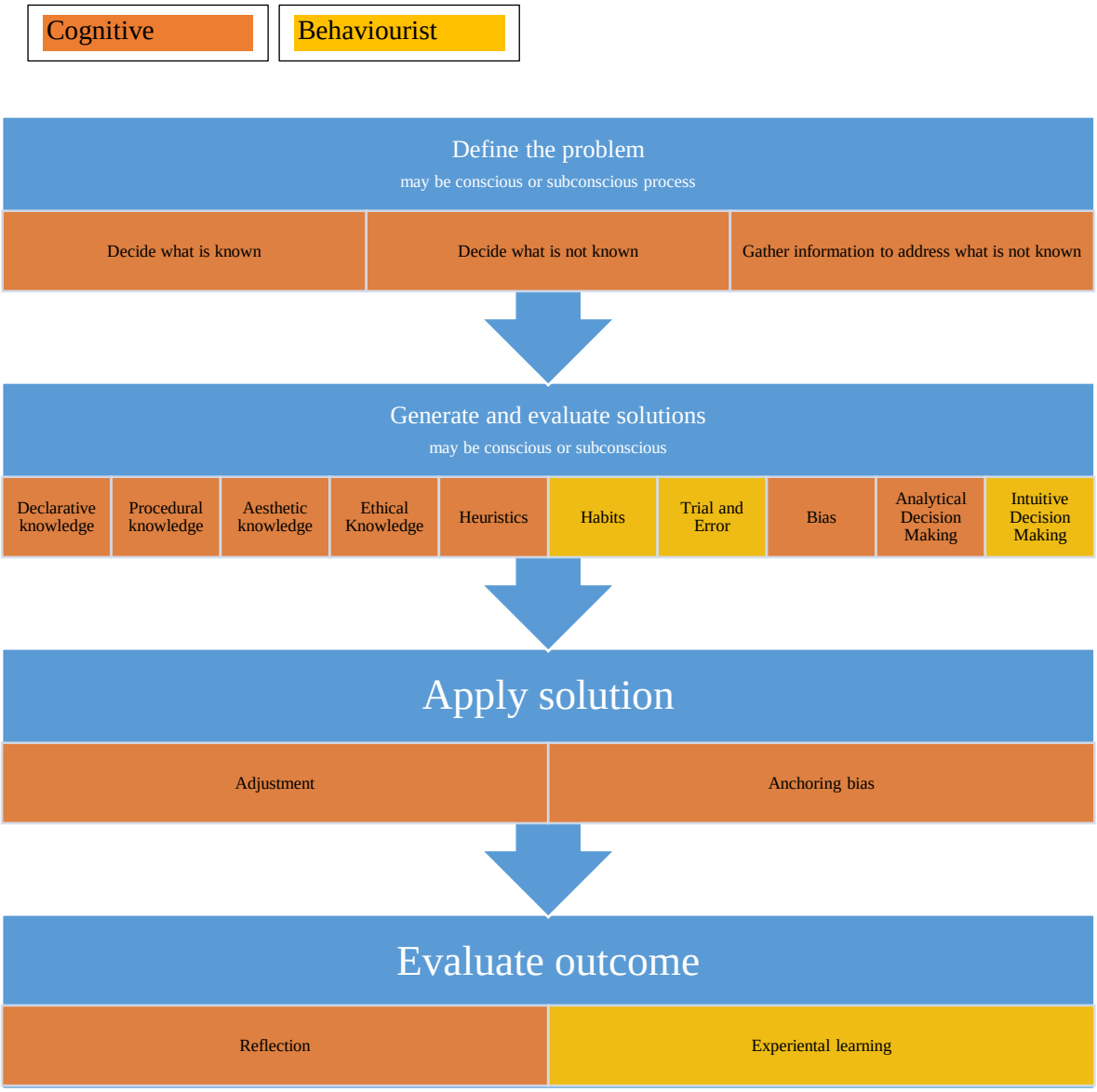
This stage of the process is self-explanatory. It is at this stage of the process that the chosen solution is applied to the problem. During this process as a result of further information the selected solution may prove unsatisfactory and an adjustment is made, as noted previously the adjustment often follows a similar pattern to the initial solution as a result of the anchoring bias.

2.2.4. Step 4: Evaluate outcome

Similar to the Newel and Simon (1972) problem-solving model McFall's model (1982) includes an evaluation phase which occurs after the solution has been applied and allows reflection on the outcome to inform future actions and learn from the experience. This current research into radiographer problem solving was not conducted to evaluate the outcome of the problem-solving process. Each problem in this research has its own context and participants. In order to evaluate the outcome the perspectives of the patient, radiographer and reporting radiographer or radiologist would need to be considered. It is quite possible that these perspectives would not be concordant as the patient and radiographer may feel that a decision not to move the patient was appropriate but the reporter may feel it was an incorrect decision as it did not result in an optimal image. It could be argued that the image produced in a radiographic examination could be used for evaluation as two of the three stakeholders (the radiographer and reporter) in the imaging process might base their decision on the acceptability of the solution on the image. The patient however is not interested in the image itself, they are interested in their diagnosis and they (as might the radiographer) will form an opinion based on the discomfort of the examination. Certainly the radiographic image can be considered an artefact of the examination as can the notes recorded on the computer system following the examination however these do not represent the whole of the examination.

Figure 4. Model of problem-solving theories synthesised from literature review above related to the steps of the Newel and Simon model of problem-solving (1972)

Colours used to denote difference between approaches

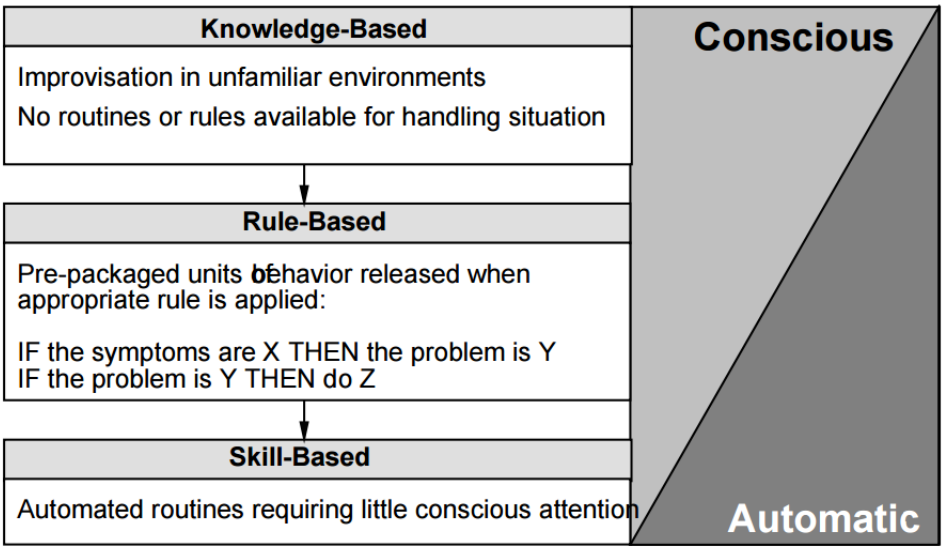


2.3. Conscious and subconscious problem solving

While it is clear from the literature already reviewed that some processes are conscious and others subconscious it is not clear when and why different levels of consciousness are required. Rasmussen's model (1983) and the work of Reason (1990) provide an explanation of when more cognitive effort might be required in problem solving. Rasmussen (1983) developed a model which suggests that a routine situation requires skills and little cognitive

input to manage it, a less familiar task employs rules which require minimal cognitive input and new situations require high cognitive input drawing upon knowledge to plan and problem solve. He describes the response to routine situations as automated and smooth (skills based behaviour), the next level (rules based behaviour) uses previous experience from similar familiar situations to combine learned behaviours to solve the problem. Novel problems utilise the most cognitive effort which requires a review of the aims and planning which makes the problem solving a slow process (knowledge based behaviour). This model compliments the work of Kahneman (2011) who suggests that the brain operates as two separate systems, the first (system one) is fast, and intuitive, readily open to error and bias and system two requires effortful thought and is slower. It should be noted that Rasmussen (1983) acknowledges that differentiation between skills based behaviour and rules based behaviour is difficult and is in part dependent upon the skills and experience of the problem solver. Reason's work (1990) is concerned with errors in problem-solving and how to manage and reduce these. In order to do this he considers how problems are solved in order to identify how errors occur. His work helped Embrey (2007) develop the continuum between conscious and automatic behaviour illustrated in figure 5.

Figure 5. Embrey's continuum between conscious and automatic behaviour, 2007 (based on Reason 1990)



- It can be noted that rule based behaviour draws on the same concepts as Klein's recognition primed decision-making (1989) with simplistic "if ...then" rules applied and can be linked to the sensory memory retrieval suggested by information processing theories.

It can be surmised from this model that as experience increases, skills and rules accumulated increase and less novel situations are encountered, this is why situations become routine and solutions to routine problems easier to find. It seems possible that experts appear intuitive because increased experience has allowed the development of more rules, tacit knowledge and skills which reduce the observer's ability to differentiate between skills and rules based behaviour. Rasmussen (1983) also tells us that if the problem solver cannot explain what they did it is likely to be a skills based level of function. Benner (1984) draws on her nursing experience to inform us that experts in practice find it difficult to explain their actions since they are subconscious and skills based. Benner's work suggests five stages of clinical competence describing the journey from novice to expert. While considered seminal, Benner's work has been deliberated by Gobet and Chassy (2008) and is thought to provide too simplistic an account of a complex context and does not sufficiently reflect analytical problem solving (conscious) in what she considers to be intuitive problem solving. Much of the literature describes an increased cognitive input required for complex problem solving (Embrey, 2007, Hardin, 2002) while Benner (1984) describes this as intuitive.

2.4. Personality in problem solving

Rasmussen (1983) tells us that the skills and experience of the problem solver can affect their approach to skills based and rules based problem solving but other factors can also affect a problem solvers approach. Morera et al. (2006) describe differing approaches to problem solving: positive problem orientation, negative problem orientation, rational problem solving, impulsivity/carelessness style and avoidance style. People exhibiting positive problem orientation approach problems in a positive way, confident that they can solve them with time and effort. Conversely a negative problem orientation indicates that the problem solver finds problems challenging and lacks confidence in their ability to solve problems. Rational problem solvers have an effective systematic approach to the process; they identify potential difficulties, set appropriate goals and identify a range of options by carefully selecting the most appropriate solution. Impulsive/careless styles use quick, ill thought through and incomplete processes to identify a narrow range of solutions. As the name suggests an avoidance style means that problems are ignored in the hope that they will resolve, or the responsibility for the problem is shifted to somebody else. This research did not gather data about the personality types of the radiographer informants although some personality traits were identified. At present very little is known of problem solving in radiography practice

and a general understanding needs development before more detailed concepts such as personality can be explored.

2.5. Problem solving in clinical practice

Real life problem solving has been given different names in the field of psychology (real world, social, (D'Zurrila & Nezu, 1982)) and this is also the case in clinical practice where the terms, clinical judgement, clinical reasoning, critical thinking and clinical decision making are used interchangeably amongst the professions (Levett-Jones et al., 2009). This mixed approach to naming the concept makes review of what is known complex. It was decided to review literature from the two professions with the most significant research and publications in this area: nursing and physiotherapy. When writing a review of current understanding Banning (2008) identified more than a thousand articles considering problem solving in nursing. It was not possible to review all this literature and thus publications which added to the theoretical understanding of clinical problem-solving and papers which investigated problem solving in the triage setting were selected to help inform this research. The triage setting was selected as this environment is similar to that in which the trauma radiographer works i.e. dynamic and time pressured. Radiographers and triage nurses work as a team to provide the fastest most accurate diagnosis for a patient who has sustained a trauma.

2.5.1. Problem solving in nursing

Some nursing professionals have been researching the problem-solving process since the 1950s and have developed a concept known as the nursing process; a five step model of problem-solving which incorporates assessment, diagnosis, planning, implementation and evaluation. Lipe and Beasley (2004) have successfully mapped this process against recognised models of problem-solving. The nursing process has been criticised for its linear approach to problem solving (Walsh, 1998) notwithstanding this the attraction of a standardised, documentable approach to the problem has meant that it is still in use today (Murphy, Williams, Pridmore, 2010) with some work having been undertaken to develop it into a six stage model with the incorporation of "outcome identification" (Alfaro-LeFevre, 2009). While a model has been developed there is still a call to understand the cognitive processes employed in nurse problem solving (Harbison, 1991, Banning, 2008). This will be considered first.

In 1997 Taylor conducted a study into nursing problem solving in the clinical setting. This study employed observation and interview methods to gather the data. The research conducted used an information-processing model to provide structure for the gathering and interpretation of the data. As noted previously this approach could be criticised for its lack of attention to the context, emotions and motivations of the research participants. The results described a "diagnostic reasoning" process a term loaned from medical practitioner research. The process has similar elements to the problem-solving models described earlier in this chapter. The results suggested that "pre encounter data" (information gained about the patient before meeting the patient) was used to help inform the problem-solving process and to focus on the information that was relevant to the problem in hand. Cues were then used when working with the patient; novice practitioners missing cues which more experienced practitioners accounted for and acted upon. When discussing cues it was noted that experienced staff had routines in place which saved time. These could be equated with the rules based behaviour proposed by Rasmussen (1987) but this link was not explored as the concept of intuition was not considered to be sound or legitimate by this author. This is likely to be related to the year this paper was published as although Benner (1984) had discussed expert intuition, the notion of intuition was only being tentatively explored in nursing literature at this time. Other findings suggested that hypothesising solutions to the problem occurred at the same time as cues were being gathered and that gathering together of similar ideas, solutions or concepts "chunking" is conducted in the short term memory allowing it to hold more data and to allow quick actions but it is not clear how this information is derived from the interview and observation data. Perhaps this is due to Taylor's interpretation of the data in relation to the information processing model but this is not explicitly stated.

In 2000, Taylor continued her work in this field by conducting a review of problem-solving publications in nursing. Taylor acknowledges that this is a little explored field of practice and that most research in this area had been conducted using simulation and replication rather than real life practice and therefore noted the limitations of these theories. Rather than reviewing problem-solving models she explored several theories of problem-solving in an attempt to identify shared concepts which could be used to develop a model applicable in a range of clinical settings by a variety of health professionals. The rationale for the selection of theories to consider is unclear as she includes a theory which is mathematical and could not be applied in practice as it does not include behaviourist or cognitive theories. Her work concludes with an acknowledgement of some similarities in problem-solving theories related

to solution generation and testing by further questioning and cue seeking from the patient. She also acknowledges that clinical problem solving uses inductive reasoning rather than deductive reasoning thus acknowledging the perspective of the individual problem solver in the process.

Seven years later Banning (2007) conducted a review to investigate clinical problem solving in nursing using information processing, intuitive-humanistic and a clinical decision-making model. At this time there was an established understanding of intuition in problem solving and Banning explains this in her work. The clinical decision-making model was developed by Oneill et al. (2005) following extensive work in this field from 1995-2005 and was based on a computerised decision support system developed to support inexperienced staff. This model is a hybrid of the hypothesis generation of information processing and intuitive problem solving (Oneill et al., 2005). The review is not critical rather it presents an overview of the current understanding of nursing problem-solving models. It provides a useful overview and summary of what was known in 2007 but adds no new knowledge and suggests that the theories need to be tested in applied settings.

In 2011 Lamb and Sevdalis conducted a literature review of nurse decision-making as part of the problem-solving process. Their review tells us that decision-making in nursing is under researched and that decision-making is a complex process involving psychology and sociology. They also note that exploration of decision skills can be complex requiring quantitative and qualitative studies. The paper summarises the variety of research methods and the areas they are used to investigate. The paper suggests that the key areas for investigation should be used to help develop educational tools to improve the decision making of inexperienced staff. It also makes an important point about the increase in team decision making and the requirements for multi-disciplinary team (MDT) decisions. This is particularly relevant in radiography where inclusion in MDT meetings is increasing as radiographer practice is advancing (Royal College of Radiologists and Society and College of Radiographers, 2012). Team decision making is not the focus of this research but it may be uncovered in the research process.

It can be seen from the works discussed above that the nursing profession has been considering the skills needed for problem solving for some time and has developed several theoretical models which might applied in the clinical setting. These theories will be considered further by examining their application in practice.

In 2001 Gerdtz and Bucknall conducted an observational study of urgency assessment in an Accident and Emergency department, a dynamic setting for nurses' problem solving and decision making. In this study nurses triaged patients to determine how urgently they needed to see a doctor. This study employed a structured observation, using a 20 item instrument to gather data related to how many decisions were made and a range of nurse and patient factors e.g. gender, length of experience (nurse), mental state (patient). This tool allowed statistical analysis with frequencies and percentages calculated. The data recorded what happened but failed to record why things happened, the underpinning rationale and cognitive processes were not captured due to the design of the study. Key findings from the paper suggested that many subjective factors influenced the decision making of the nurses but these were not captured by the instrument. The data collection instrument did not help the authors to understand why physiological assessment was not conducted on every patient. This study added little to the knowledge of how decisions are made but added information about some of the factors nurses consider when making decisions e.g. limb observation and neurological tests, and how long that process takes them.

Review of this study suggested that the use of research instruments and statistical analysis would not provide a valuable insight into radiographer problem solving in the clinical setting because it did not explain why or how decisions were made but was useful in indicating that a wide range of factors are considered when assessing patients in triage some of which are subjective.

In 2006, Andersson, Omberg and Svedlund conducted an observational study of the factors considered by nurses when making decisions in the triage setting. Their method employed short interviews following the observation which were used to question the nurses about their decision-making priorities. The paper considers many factors which influence decision making for nurses but a key area of interest for this research was their discussion of the assessment of the patient. Nurses gathered information about the general condition of the patient, about the duration of the patient condition or assessment of its changes within a time frame, and they also assessed threat to the patient (from their illness/injury) using intuition and knowledge to form this judgement. Nurses also assessed pain using a visual analogue scale, they used other test results (bloods, oxygen saturation, and blood pressure) to inform their decision and they conducted a physical examination of the patient looking for mobility, swelling and position. Importantly these are all factors a radiographer might consider when deciding how much to move a patient for an imaging examination.

In 2003, MacGeorge and Nelson conducted a study to evaluate whether experience influenced decision making in the administration of positive pressure oxygen therapy in the emergency setting. This retrospective study used non-experimental correlation to compare data on past cases to explore the research question. MacGeorge and Nelson suggested a trend in the findings, which indicated that nurses with more experience acted more quickly in their decision-making, positively influencing patient outcomes. The authors concluded that there is a need to improve education to facilitate prompt decision making in the practice setting. This study was not assessing the overall experience of the nurses rather it considered their experience in the triage setting, concluding that those with more triage experience acted faster based on their subjective observations of the patient. This concept maps well with cues described by Taylor (1997) and Rasmussen's (1983) concept of knowledge and rule based problem solving.

Similarly in 2006 Göransson, Ehrenberg, Marklund and Ehnfors conducted a study to evaluate whether varying characteristics influenced the decision-making skills of nurses in the triage setting. They used a number of piloted simulations to measure the accuracy of urgency assessment by nurses with a range of experience and background. This was a quantitative study which used statistical analysis to measure accuracy and to correlate their findings with the demographic data related to the participants. They found only one correlation within the figures which suggested there was a link between appropriate clinical experience and accuracy, not length of experience or age of participant. It is important to note that it was not general nursing experience that was key but experience of working within that sphere of practice. They suggest that these findings are similar to other studies in this area and that further work is required.

These papers describe something of the theory of nursing decision-making and the types of problem solving applied, the value of experience within specific areas of practice and the information considered by nurses when problem solving. Problem solving in physiotherapy practice will now be explored.

2.5.2. Problem solving in physiotherapy

Physiotherapy researchers have been discussing problem solving and clinical reasoning since the 1990s. In 1993 Terry and Higgs considered how to improve the clinical reasoning and decision-making skills of physiotherapists through education, in response to the increasing

autonomy of physiotherapists. They defined clinical reasoning as the cognitive and decision-making skills needed in practice. As recognised by works considered earlier Terry and Higgs (1993) suggested that the development of problem-solving skills needs a sound base of knowledge, both academic and experiential but also suggested that good patient communication skills are required to facilitate information gathering. Their work discusses information gathering as a dynamic and key component of problem-solving. This maps well with the concept of cues from nursing (Taylor, 1997). Although they do not discuss decision models there is an implication that they are describing analytical decision-making. As with early nursing work this may be due to the lack of understanding of intuition at this time. They also suggest that clinical staff may use methods and techniques that they have used successfully previously, which could be recognition primed decision-making (Klein, 1989) or knowledge/rules based problem solving from the work of Rasmussen (1983). In order to improve education in these skills they suggest the use of problem based learning and practice in the clinical setting.

In 2006 in their two part paper Chipchase and Prentice discuss patient mobilisation using physiotherapy decision making in the acute setting. The paper reports the findings of an ethnographic research project to identify the elements contributing to mobility decision making. Similar to the nursing studies the findings of this work indicate that physiotherapists use patient history and background, information from observations of the patient's presentation, both physical and psychological, and information received when moving the patient to assess patient mobility. These are factors which could readily be assessed by radiographers when deciding how much to move a patient and are important factors for consideration in this research.

In 2008 Smith, Higgs and Ellis acknowledged that while there is literature related to problem-solving within other disciplines of physiotherapy there is limited work related to problem-solving within the field of cardio-respiratory physiotherapy. They suggest that physiotherapist decision making is more complex than initially considered and needs further evaluation. The researchers used observation and interview to gather data in the clinical setting. They found that problem solving varied and was dependent upon the complexity, dynamism of the situation and practitioner experience. 'Routine' decisions were made when cases were not complex, held little uncertainty and outcomes were predictable. More complex decisions required more cognitive activity with comparisons, risk analysis and experimentation. This type of decision appears to map with analytical rather than intuitive

decision making which is concomitant with the work of Embrey (2007) and the continuum he developed in the previous year. Further complications in patient cases saw physiotherapists seeking support with their decision making from colleagues and members of other professions.

Building on her earlier work in 2008 Higgs, Jones, Loftus and Christensen edited a book 'Clinical reasoning in health professions' which summarises the findings of research conducted in physiotherapy problem- solving. The book has several chapters related to decision-making and also has a chapter dedicated to how best to conduct decision-making research. The book provides a comprehensive overview of what is known about physiotherapist decision-making and applies it to more generalised practice for other health professionals. The authors discuss collaboration with the patient and the patient's contribution to the decision process. This does not apply directly to radiography due to the nature of the profession. Radiography is a diagnostic profession, the patient has limited options, either to have the recommended examination or not. Patient collaboration is not considered in this research other than the ability of the patient to comply with the radiographers' direction for positioning. Higgs et al. (2008) provide an insight into the practice models of physiotherapy and discuss the philosophy of models of practice. They suggest that the profession follows the medical practice model and discusses this in the context of the work of Habermas (1972). While providing an insight into the way a physiotherapist might perceive their role in the care of the patient and their approach in this respect it does little to describe what models of clinical reasoning (problem solving) are applied in practice.

2.5.3. Radiographer problem solving and decision making

Radiography is generally regarded as a profession steeped in positivism with its limited research activity having a quantitative focus until recent times (Curtise & White, 2005). As Schön (1983) suggests, professions based in positivism are more concerned with technical rationality, the learning and development of profession specific knowledge, than the concept of skills needed to apply the knowledge. Positivist professions find the concept of skills being knowledge "uncomfortable". They are more concerned with the acquisition of facts as knowledge than how the knowledge is applied in practice.

Foulcault (1975) discussed the idea of knowledge and power as a difficulty in the medical profession and identified the concept of the "medical gaze" or "clinical gaze". This notion described the way in which a doctor used their knowledge and power to separate the ailment of the patient from the person themselves. Using the "clinical gaze" draws upon the knowledge of the doctor and their observations of the patient to understand their illness. This is thought to dehumanize the patient and fail to foster "patient centred" care. Radiography as a profession developed under the auspices of the medical profession (Price, 2001) and may have adopted this reductionist approach in its practice with their primary focus being production of a diagnostic image rather than patient care.

Research conducted by radiographers in the field of radiography has chiefly been of an empirical nature concerned with radiation dose and image quality. Limited attention has been paid to those skills which the radiographer employs to support the technical acquisition of images with the lowest dose. Extensive searches of three data bases (SCOPUS, ISI Web of Knowledge, and Google Scholar) have identified very few relevant papers related to the process of clinical problem solving in radiography. Searches were conducted within SCOPUS, Web of Knowledge and Google Scholar as it is considered that a search of these databases would identify any literature produced within this field and research has suggested that each of these databases have their own strengths in terms of article dates and topics. Using all three ensured the best potential retrieval rates (Fingerman, 2006, Bakkalbasi, Bauer, Glover & Wang, 2006)

Boolean logic (Harvard, 2007) was used to help derive the terms used to search for articles related to radiographer problem solving and decision making. It was also necessary to consider the American term for a radiographer and so included 'radiology technologist'.

Search terms used were:

Rad* AND clinical AND decision OR judgement OR reasoning process OR problem solving

Rad* AND decision OR judgement making OR reasoning process OR problem solving

Clinical AND decision OR judgement making OR reasoning OR problem solving in rad*

Date settings were broad to include any papers written since the 1970s, before the earliest physiotherapy publications in this field, in order to gather as much information as possible and ensure none were missed.

These searches identified several genres of papers which were not relevant to this research many of which were related to the decision to refer a patient for imaging or signal detection theory used to analyse image quality. Very few papers related to this area of research were identified and none which addressed problem solving in this specific area of clinical practice. Some papers related to radiographer decision making were retrieved.

The earliest work which discussed radiographer decision making was produced by Bowman in 1995, "Decisions made by radiographers when working on call in an accident and emergency imaging department. An evaluation of the modes of decision-making used by radiographers as part of their radiographic clinical practice using participant observation". This title suggests that it would provide useful information in relation to radiographer decision making in the clinical setting, as well as information describing a potential method of examining this area of practice. Unfortunately even direct contact with the author failed to retrieve this article, which was published in a journal 20 years ago, it was in print for a short time with only 4 issues produced. It is not available electronically. Bowman continued to research in this field and produced a second article in 1997.This paper while still considering decision-making had a more narrow focus than his earlier work; examining the evaluation of the acceptability of radiographs. In his introductory paragraphs Bowman discussed the difference between judgements and decisions. In this section he describes the concept of judgements as a scale of acceptability between two points on a continuum. Unfortunately this unfamiliar concept is not supported with academic references and it has not been possible to identify this definition in the problem-solving literature review, as a result it is unclear how he reaches this conclusion. The concept of value assignment where numerical grades are awarded on a continuum (similar to a Likert scale (1932)) has strong associations with analytical decision making where a low or high value could indicate a correct outcome and allow selection of a best outcome. The discussion of this unsupported concept early in the work suggests some unintended bias towards analytical problem solving. This suggestion is furthered by Bowman's literature review which provides a much shorter and more negative review of intuitive decision making in comparison with analytical decision making. While this criticism should be noted it is important to recognise that the concept of intuition was not fully understood and described in the literature at the time Bowman was writing this paper. There follows the outcomes of the study which are presented using an analytical framework. There is no explanation of how the study was conducted other than a brief mention of 'observation'. This lack of detail is a common criticism of qualitative studies (Lundgren-Lane

& Salantera, 2009) and is not helpful to others considering similar concepts and wishing to replicate studies. The results provide an analytical approach to illustrate the various factors radiographers consider when deciding whether to accept or repeat an image. The work presents a decision tree with elements combining to inform the decision process. The elements are scales of tolerances that the radiographers have decided upon themselves and are based on their individual education and experience which he terms "encapsulated knowledge". This appears to be comparable with the rules based behaviour suggested by Rasmussen (1983) but despite rules based behaviour being an earlier insight it is not discussed in Bowman's work. The analytical model presented demonstrates a step by step process typical of decision aids developed using an information processing model which assumes that steps are sequential and does not reflect the potential parallel processing conducted by the human brain (McLeod 2008). Bowman goes on to discuss what happens when staff seek support with decisions from colleagues. He considers staff to be requiring support and advice in reaching a decision but does not consider the emotional context of support as suggested by Zeleny (1982). Asking colleagues for support and advice is an interesting concept as seeking the opinion of a colleague who was not present when the examination was conducted will have a direct influence on the third stage of judgements that Bowman describes, where the decision maker considers the contextual environment.

There is a wealth of research literature which discusses consensus decision-making and 'group think' (Janis, 1972, Hogg & Vaughan, 2008).Work in this area suggests that those involved in this type of decision-making are often more concerned with reaching a consensus of opinion and may thus not use rational decision making. "Group think" work has a direct relation to that of Bowman since he suggests that radiographers seek the opinion of others to support their decisions and the desire for a consensual decision may over rule the radiographer's initial decision to accept or repeat the image.

Bowman notes that despite devising a quantitative model, observations have suggested that radiographers use intuitive decision making. The conclusion of the paper suggests that the profession needs to provide direction about which decision model should be used in practice. It could be argued that there is no best way for a practitioner to make decisions since these processes are influenced by experience, context, personal preference, personality and the problem itself. Bowman himself acknowledges that intuitive decision making can be as

accurate as analytical problem solving but analytical processing is time consuming and not best suited to a fast paced clinical environment.

In 2000 Prime and Le Masurier studied radiographer decision making using "think aloud" techniques. In comparison with Bowman's work this study employed a clearly explained and well recognised methodology "think aloud" (Ericson & Simon, 1993). Fifty six radiographer participants with varied lengths of experience observed a pre-recorded video of a clinical examination and were asked to comment upon the activities of the radiographer in the scenario as the activities were undertaken. The whole examination was reviewed rather than a specific element of the examination and thus provided an overview of all aspects of the examination. The data was analysed using coding of themes within the data and examples of comments were included. Of particular interest to help inform this current research were comments about the order the examination was conducted, comments about the role of the radiographer in questioning the patient (the participants did not appear to approve of this) and one comment about how the radiographer touched the injured body part with the research participant suggesting that they would be reluctant to touch the injury site. Another interesting theme was that the participants felt that they would not have had as much time in practice to chat to the patient as the radiographer in the recorded scenarios did. This lack of time may be an influencing factor on decision making. The study had collated detailed information about the participants but could not correlate any of the factors to the frequency of coded data. The authors critique their methodology and suggest that further studies should be conducted in practice. The research indicated that a radiographer groups knowledge together in order to aid decision making using "encapsulated knowledge" drawing on Bowman's work (1997) to inform this. The lack of correlation between experience and encapsulated knowledge was also considered to suggest that radiographers move quickly from a novice state to other points on Benner's stages of expertise (1984). The work concludes with the suggestion that radiographer decision making is unstructured and does not draw on peers, or protocols.

In the following year Baird and Wells (2001) were discussing the development of a computer based case study teaching package. The paper discusses the difficulties students have in making links between theoretical knowledge and clinical practice. The case studies they developed were designed to encourage students to problem-solve and make decisions in the way that clinicians would in practice. Having reviewed the case study material students were

expected to develop an action plan which they submitted to an expert for review and feedback. Of particular interest is the wide variety of evidence the students required to provide them with enough information to problem solve. The designers of the programme included, letters and documents, patient scenarios, audio-visual scenarios, procedural scenarios, and conversations. Although not the intention of the designers/authors these elements implicitly indicate the wide variety of information sources that radiographers draw upon to problem solve and decision make. The authors piloted their tool and evaluated the tool with the students. Interestingly while liking the tool and feeling that it is valuable they asked for longer to solve the problems. This might suggest that these novice radiographers do not have sufficient experience to draw upon and have not developed knowledge or rules based problem-solving skills (encapsulated knowledge –Bowman, 1997) and were relying on slower and more methodical analytical processing to solve the problem. The article cites a student comment about previous experience. The authors use this to demonstrate that the students are making links with practice but from the perspective of this problem-solving research it contains a different message about experience informing practice. The student says "The cases were useful-especially if one had covered the topic while on clinical visits……If you had already done it the case was easier and if you hadn't there was a lot to learn…". This quote suggests that even having had some clinical experience in a relevant area makes problem solving less difficult, having limited experience has allowed the student to know what to do. This is consistent with the findings of Prime and Le Masurier (2000) and Göransson (2006).

In 2004 Lam, Egan, and Baird investigated how additional information gathered by radiographers might influence the clinical decision making of radiologists. They employed a structured template, which the radiographer completed, this was then given to the radiologist to help inform the diagnostic reasoning of the radiologist reporting the image. As part of the study the radiographers were required to comment upon the adequacy of the clinical histories provided and to report any changes to their clinical decisions based upon the completion of the template. The results suggested that 20% of the request cards were inadequate either as a result of a lack of clinical information or illegibility. Interestingly in 18% of the cases the gathering of additional information resulted in a change in the radiographic examination. For example in one single case the additional information gathered changed the projections obtained, adapting one and including an additional projection, and decreased the radiographic exposure when it was discovered that the patient was osteoporotic. It can be seen that

gathering additional information had an impact on the problem solving and decision making of the radiographers. This is interesting as in the study conducted by Prime and Le Masurier (2000) the participants appeared to disapprove of the extended questioning they observed but this study suggests that there are benefits to extended questioning. The radiographers in this study felt that the additional questioning improved their relationship with the patient but acknowledged that the additional questioning extended the examination by 2-3 minutes potentially delaying patient examinations, the same argument used by Prime and Le Masuriers' participants. The work concludes that additional information gathering is recommended as it improves patient care and diagnosis and goes on to recommend that radiographers should be trained in patient history taking and interview skills. Little progress has been made on this to date.

In 2008 Larsson, Lundberg and Hillergård investigated radiographers' knowledge in image production. This study is structured around Blackler's theory of knowledge (1995). Blackler based his work on that of Collins (1993). Blackler tells us of 5 types of knowledge: embrained, embodied, encultured, embedded and encoded. Embrained knowledge is practical high level knowledge (knowing that) which may be tacit, embodied knowledge is socially acquired practical knowledge developed in a social setting (knowing how), encultured knowledge is a shared social understanding, embedded knowledge is subconscious and related to routines, roles and procedures, and encoded knowledge is information stored as signs and symbols. Three elements were considered for this study; embrained, encoded and embodied knowledge. Embrained knowledge equates with declarative knowledge (Rittle-Johnson & Koedinger, 2005) and embodied knowledge equates with procedural knowledge (Bisanz & LeFevre, 1990) as discussed earlier in this chapter. This study employed ethnography to investigate the types of knowing demonstrated in radiographers' clinical practice in the trauma setting using both semi-structured interviews and observations to gather data. The study found evidence of all three elements of knowledge in the radiographers' practice used at different points in each examination. The work also identified when the radiographer is working as a "routine actor" or as a "reflective actor" the latter implying a level of cognitive engagement not required for routine practice. In their conclusion the authors also recognised that using cognitive skills is not related to experience but is related to personality and the department working practices and therefore will differ.

In the same year (2008) Andersson, Fridlund, Elgan, and Axelsson, published their paper investigating the balance between nursing skills and technical skills in radiographic practice "Radiographers' areas of professional competence related to good nursing care". Radiographer training in this region of Europe is closely allied with nurse training and radiographers are considered to be radiography nurses in Sweden which is not typical of radiography in the UK and may explain the authors' interest in the more caring aspect of the radiographers' role. The paper investigates the dual roles undertaken by the radiographer in caring for the patient while operating the technical equipment required to image the patient. The paper introduces the concept of professional competence and explains this as the knowledge and skills required to undertake the task, some of the knowledge being gained when learning from experience. As previously identified these are important concepts in relation to this current research. Caring is defined as something which demonstrates empathy and respect while empowering the patient. Their study was conducted using semi-structured interviews and written reports of fourteen participants who were asked to describe incidents related to nursing care which were significant to them or their practice, a qualitative approach known as Critical Incident Technique (Flanagan, 1954). Significant events could be successful or difficult situations encountered in practice. The study identified two forms of nursing care, "direct" where contact with the patient was required and "indirect" care when no contact occurred. Four elements of direct care were identified which encompassed communication with the patient, performing the examination, demonstrating empathy with the patient and monitoring the patient and acting on their behalf. The four elements of indirect care identified were organisation, ensuring quality (including equipment checks), appropriate image production and storage and collaboration for the purposes of information sharing and education and are chiefly management elements of the examination. Directly related to this research, was "direct" care where the work suggests that the radiographer needs to be able to assess the patients' ability to undergo the examination using their physiological knowledge and to draw on experience when examinations required adaptation but the study does not explain how this might be achieved. The study also emphasises the importance of communication with the patient to improve their experience of the examination. It goes on to conclude that the balance between achieving the technical images required and caring for the patient can provide a difficult and ethically challenging situation for the radiographer but does not provide advice in relation to this and goes on to suggest further research is need in this area of radiographer practice.

In 2014 Lundvall, Dahlgren and Wirell, reported the findings of their phenomenological study of the "radiographic process". The study was conducted using interview and observation of radiographers performing general radiography, computed tomography (CT) and magnetic resonance imaging (MRI). The results suggested that radiographers employ a three stage process in order to conduct an examination: planning the examination, producing the images, and evaluating the examination. They expand upon the planning of the examination by explaining that it includes examining the referral request, observing and questioning the patient to gather additional information, assessing the patients' ability to comprehend and finally attending to safety issues. It is not clear whether these elements of planning are conducted in the order presented or if they occur simultaneously though the description suggests it is sequential. However this may not be the case as it might be assumed that safety issues could also be considered when reviewing the referral request. In their discussion of producing the image the authors briefly mention ensuring the patient is positioned correctly and safely but do not provide the detail of how this is achieved. For CT and MRI imaging it is important that the patient can maintain their position during examinations which will last minutes and this is acknowledged when the participants communicate with the patient to explain that while the position is uncomfortable it is necessary to remain still to achieve good image quality. The work is concluded with a discussion of several aspects of the findings the most significant of these, in relation to this current research, are that the radiographers feel able to visualise the projections before conducting the examination to help them position the patient safely and that establishing the patients' co-operation is important for patient care and positioning but it is not clear how this is achieved.

In 2015 Nightingale et al. discuss mammographer problem solving and decision making in breast compression for mammographic examinations. This study reviewed data gathered previously from focus group and individual semi-structured interviews as part of a phenomenological study. A thematic analysis of the data revealed a seven stage problem-solving and decision-making process which maps in part with the process described by Lundvall, Dahlgren and Wirell (2014) but provides greater detail within each phase of the problem-solving process. Of relevance to this current research the work describes the assessment of the request card for information relevant to the examination (pre-encounter data- Taylor, 1997) their impression of the patient when they meet them and the subsequent factors which influence the process as they undertake the examination (cues-Taylor, 1997).

This work also attempts to map some of the radiographer behaviours with existing problem-solving models. The work concludes with the suggestion that this model could be transferable to other areas of radiographer practice and complex problem solving should be examined there.

2.6. Summary of the chapter

This chapter has described the complex nature of problem-solving and investigated what is required of each step of the problem-solving process. It is clear that there is a wealth of literature published which explains the problem-solving process from many theoretical perspectives. Applying this knowledge to other health professions it can be seen that there is good understanding of the process with some professions having developed their own models. In nursing the "nursing process" is a well described six stage process which despite its acknowledged limitations is used in everyday nursing practice. Having developed their model nurses have started to investigate the knowledge and skills required to undertake the processes. These studies have revealed that nurses gather a large amount of information about the patient to inform the process before they meet the patient (pre-encounter data) and during their time with the patient (cues). Investigation also revealed that experienced staff use rules based problem solving and that they acted more quickly in practice when they were experienced within that field of practice.

Physiotherapy research suggests the use of analytical and intuitive problem solving, describing some well recognised models. Physiotherapy studies also discussed the information gathered to inform the process and discussed the cognitive engagement required in more complex problems.

In radiography, the review of the limited papers available suggest that similar to other health care professions radiographers use intuitive problem solving in practice and that clinical problems are solved quickly. Although analytical problem solving is discussed it is not seen in practice. Radiographers appear to demonstrate rule based problem solving and gather information about the patient prior to conducting the examination. It is also noted that some information sources can be inadequate (request cards). The review also suggests that radiographers may gain experience quickly helping them to problem solve in clinical practice.

Many of the publications from practitioners from all the professions considered criticise the experimental nature of much research in this field and later studies are conducted in the clinical setting using observation and interview to help understand the problem-solving process. This current research was conducted in the clinical setting in order to gain an understanding of actual practice.

Many of the studies of radiographer practice reviewed the whole scope of radiographic examinations which provide a general overview but little depth of understanding. It can be seen that little is known of the detail of problem-solving in general radiography (and other professions) with most publications suggesting further work in this field. While an overview is helpful more detail is required to provide a depth of understanding. This unique research investigated an element of the trauma examination in depth.

Chapter 3: Methodology

3. Introduction

This chapter will provide theoretical debate about research methodology and methods. A methodology is the process used and rationale for selecting various methods to conduct the research (Guba, 1990). A research method is the tool or tools used to collect and analyse the data (Kumar, 2005). This chapter will outline the methods used for this research and provide an academically reasoned rationale for the selections based upon the aim of the research and the stance of the researcher. The chapter will provide more detail of what was examined and the rationale for its inclusion. It will discuss the ethics of research and the tools used to consider the quality of research and to ensure research rigour.

3.1. Research paradigms

The Oxford online dictionary (http://oxforddictionaries.com/definition/english/research) defines research as "the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions" a similar description to that given by Kumar (2005). In this definition one of the key elements is the inclusion of the word "systematic" without inclusion of this concept a study is not considered to be research and this is echoed by many authors who provide a definition of research. In order to ensure that research is systematic a framework must be developed.

To conduct research the researcher must first select a topic and then identify the research paradigm. The paradigm should be selected as best suited to answer the question posed. A research paradigm tells much about the nature of the study and those undertaking the research. It includes more than a method; it includes assumptions about how the researcher sees the world, how they think knowledge is constructed, how they believe research should be conducted and what is considered to be proof (Creswell, 1998).

According to Guba (1990) each research paradigm has three elements: ontology, epistemology and methodology. Ontology is how the researcher perceives knowledge. This incorporates an understanding of what knowledge, truth and reality are. Epistemology is concerned with the relationship between the researcher and the knowledge. In some instances the researcher sees themselves as separate from the generation of knowledge and some as an

integral part of the process. Methodology is the process selected to allow the researcher to find the knowledge.

Research paradigms have evolved and changed throughout the years. Research originally conducted was constructed in a positivist paradigm. Positivism is based in rationalism, a philosophy which proposes that man learns as a result of his ability to reason (Kumar, 2005). Positivism considers that true (correct and accepted by all) facts exist (ontology). Using a deductive approach the researcher plays no part in construction of this knowledge- the knowledge was waiting to be found (epistemology) and experimental and numerical studies will uncover the truth/knowledge (methodology). This type of research aims to test theory and usually relies upon large amounts of narrowly focused statistical data to prove the new knowledge or test a theory or hypothesis. An emphasis is placed on validating the research findings by removing the researcher from the research and by generalising the findings (Scotland, 2012). It is typically known as quantitative research.

Denzin and Lincoln (2003) describe how from the positivist paradigm, a post-positivist and other research paradigms developed. They refer to times/phases at which these paradigms developed as the "seven moments" of qualitative research. These seven moments have resulted in a wealth of research paradigms, the first of which being post-positivism. This paradigm emerged from positivism and has a similar ontological and methodological approach but acknowledges that ontologically it is not possible for researchers to fully understand and see the truth. Its chief difference is in its epistemological acceptance of the concept that the researcher must impact upon the research. This approach suggests that objectivity in research cannot be achieved and researchers adopting this paradigm use many approaches to validate their findings using a variety of methods to "triangulate" their data (Guba 1990, Scotland, 2012). Some degree of triangulation was applied to this research.

Following post-positivism other paradigms emerged. Two other commonly applied paradigms are Critical Theory and Constructivism (Guba, 1990). Critical theory is a form of research which aims to identify inequalities in social and cultural situations. Critical theory is applied to feminist, social, political and ethnicity research and aims to bring about change. Constructivism acknowledges that while the world exists independent of observers knowledge is created by the observers individually or socially (Crotty, 1998). This suggests that knowledge is built by observers and can vary between observers. Research related to these paradigms tends to be conducted using a qualitative approach.

Quantitative and qualitative methods vary in other ways also. Quantitative research study employs manipulation of subjects, large numbers of data, can be quick to conduct and requires the researcher to remain distant from the subjects of research whereas qualitative research requires little or no manipulation of the subjects, can use small subject numbers, can be lengthy to conduct and researchers are often close to the subjects they are working with (Silverman, 2010).

3.2. Research ontology

Ontologically this research project was conducted in the belief that knowledge is constructed. Epistemologically the researcher believes that they cannot be removed from the research and that interpretation of the data will influence the study. This is particularly the case when the researcher is required to interpret the actions of others and construct the knowledge in order to answer the research question. The methodology selected needed to reflect the beliefs of the researcher and allow the research question to be answered truthfully. To this end a qualitative research methodology was employed.

3.3. Research epistemology

Little is known about how radiographers solve problems and make decisions in the clinical setting. This research intends to develop an understanding of problem-solving in radiographer practice. Within the field of nursing and within other health professions studies of problem solving and clinical reasoning have been successfully undertaken using observational methods (Gerdtz & Bucknall, 2001, Andersson, Omberg, Svedlund, 2006) and a strong case is made for the use of observation in decision-making research by Foody, Mendys, Lui and Simpson (2010) in their paper discussing how the outcomes of clinical trials are applied to inform the problem solving and decision making of clinicians in practice. There is limited research conducted in this area of radiographic practice, however Prime and Le Masurier (2000) recommended that decision making research is conducted in the practice setting suggesting that the authors felt observational studies would be suitable.

There are several types of qualitative research approaches which use observation: phenomenology, grounded theory and ethnography are some examples. Phenomenology is the study of experiences, developing an understanding of how an individual experiences a phenomenon and understands their behaviour (Creswell, 1998, Rossman & Rallis, 1998).

This type of research investigates an individual's perceptions of events. Phenomenological research can use a very small sample size (1 individual) in order to explain how an individual understands a situation. This project aims to understand how problem solving is addressed in the area of trauma imaging practice since little is known about it. The work does not seek to understand an individual's perspective on the process as this would not be sufficient to understand the wider process of problem-solving amongst a number of staff in a dynamic clinical setting. Using grounded theory researchers enter the field of data collection with the intention of developing a theory from the data they collect. The research premise is not to test a pre-existing theory but to investigate a phenomenon and develop a theory which explains it. Originally suggested by Glaser and Strauss (1967) this approach has been developed with time (Corbin & Strauss, 2008) and uses iterative, deductive, and inductive, methods of data analysis to develop theory explaining what is happening in a situation. Glaser espoused that induction is the key element of grounded theory however Strauss's work further developed the concept to emphasise a systematic approach and validation of results which resulted in a divergence of the methodology with both defending their stance. This research was not designed to develop new theory but to understand current practice based on pre-existing theories. Ethnography is the study of cultures or social groups (Geertz, 1973) going about routine behaviours in order to understand their behaviour (Brewer, 2000) and this appeared to be an appropriate data collection method for this research. A more detailed consideration of ethnography follows below. To confirm this decision about the research method it was necessary to consider the research groups to be observed and to decide if they and their behaviours constituted a culture or society. Radiographers work in close proximity to each other taking it in turns to use equipment within a limited number of x-ray rooms to image patients. Radiographers strive to produce diagnostic images of their patients in a timely fashion to avoid delays in the treatment of patients. In shared working environments, systems of work develop which are unwritten but are based on a set of principles accepted by those working within these areas which might not be evident to those from outside. By sharing knowledge and beliefs radiographers are working as a social group or culture within their department. Damen (1987) defined culture as "learned and shared human patterns or models for living; day- to-day living patterns. These patterns and models pervade all aspects of human social interaction" and as such radiographers working in an imaging department together can be considered a social group which forms its own culture with its own shared knowledge and beliefs.

3.4. Research method

A research method which allows the study of cultures and behaviour within a culture is ethnography. Ethnography was a term used to describe the writings of early anthropologists. It was initially used to study cultures very different to that of the anthropologist conducting the study. With time its use spread into wider areas of social study. One notable and influential group, The Chicago School, of sociologists working at Chicago University used ethnography to study different societies within the city (Hammersley & Atkinson, 2007). From the 1960s onwards the use of ethnography spread to wider areas of social and cultural interaction. Brewer (2000) explains that ethnography is a systematic method of collecting data about people undertaking their routine activities by observing them conducting the activities in their natural setting. Brewer's definition indicates that ethnography can be a study of behaviour within a culture as much as a study of a culture. This view is supported by Walliman (2001) and Silverman (2010). Fetterman (1998) compares the ethnographer to an investigative journalist, questioning, interpreting, looking for links and making judgements about the credibility of informants. He makes a key distinction that investigative journalists seek out the unusual whereas ethnographers seek out the routine and common place.

3.5. Ethnography

Ethnographic data is gathered using fieldwork and data typically comprises of observation, field notes, and interviews (Brewer, 2000). The researchers are often considered to be participants within the group under study, engaging with their activities in order to understand them. Ethnography may also require examination of the tools employed in these activities which are termed 'artefacts' (Hammersley & Atkinson, 2007).

3.5.1. Focussed ethnography

While ethnography is generally considered to be the long term study of an entire field of practice, focussed ethnography is an applied research method which allows a specific aspect of the culture to be studied (Richards, & Morse, 2007, Higginbottom , Pillay, & Boadu, 2013). Knoblauch (2005) explains that, unlike "conventional" ethnography, focussed ethnography utilises short discontinuous or episodic field visits, with the researcher acting as a field observer rather than a participant. Focussed ethnography is more concerned with actions than a typical ethnography which considers social factors. Focussed ethnographies

often employ a limited number of participants who hold the knowledge required to perform the tasks being investigated and this method is used to uncover this knowledge (Muecke, 1994). Cruz and Higginbottom (2013) provide a compelling argument for the use of focussed ethnography to investigate nursing practice and it is discussed as a pragmatic approach to some of the financial and time constrained difficulties of conventional ethnography identified by Savage (2000). Higginbottom, Pillay, & Boadu, (2013) provide a table to summarise the comparison between focussed and conventional anthropological ethnographies (Table 1)

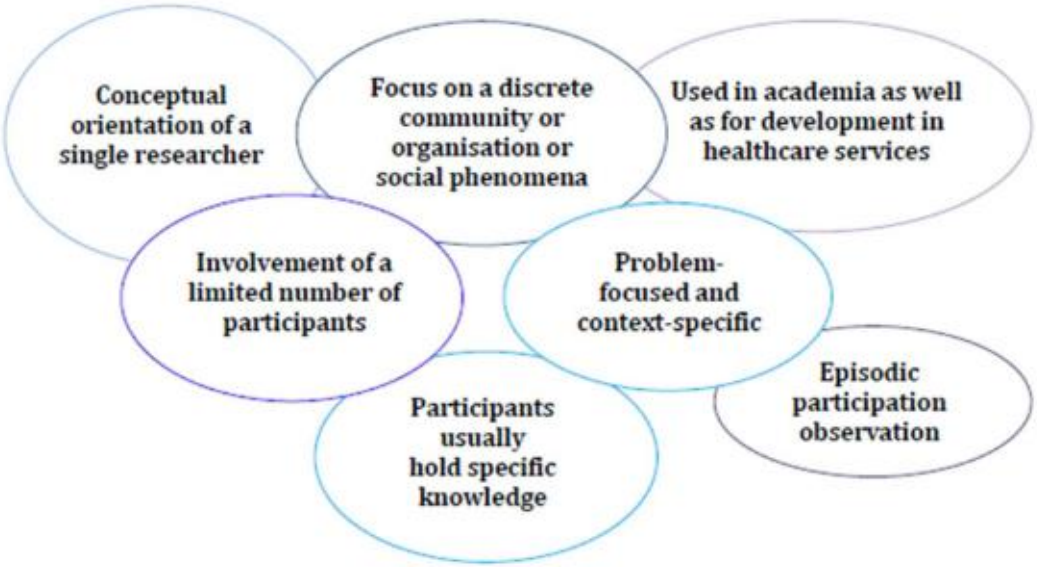
Table 1. Higginbottom, Pillay, & Boadu, (2013) comparison of ethnographies

Focussed ethnography	**Anthropologic ethnographies**
Specific aspect of field studied with purpose	Entire social field studied
Closed field of investigation as per research question	Open field of investigation as determined through time
Background knowledge usually informs research question	Researcher gains insider knowledge from participatory engagement in field
Informants serve as key participants with their knowledge and experience	Participants are often those whom the researcher has developed a close relationship
Intermittent and purposeful field visits using particular	Immersion during long-term, experiential-intense fieldwork
Data analysis intensity often with numerous recording devices including video cameras, tape recorders and photo-cameras	Narrative intensity
Data sessions with a gathering of researchers knowledgeable of the research goals may be extensively useful for providing heightened perspective to the data analysis particularly of recorded data	Individual data analysis

It can be seen that the purpose of this research is focussed and less generalised than the earlier work of Prime and Le Masurier (2000) which investigated the entire x-ray examination. Focussed ethnography would allow investigation of a specific element of the

examination in order to address the research questions. It is clear that my involvement in the radiography profession and its educational provision has informed the research question and that as a full time employee intermittent and purposeful visits would be more practicable than long term field immersion. The observation of qualified radiographers in practice will allow them to act as key participants sharing their knowledge and experience to investigate the research question. It can also be appreciated that having radiography colleagues as supervisors of the project might bring heightened perspective to the data analysis.

Figure 6. Characteristics of focussed ethnographies Higginbottom, Pillay, & Boadu,



(2013) (adapted from Muecke 1994)

Higginbottom, Pillay and Boadu (2013) go on to provide further guidance on the characteristics of focussed ethnographies by adding information about the nature of the research suggesting that is based on the orientation of a single researcher and that it can be applied in academia as well as in the healthcare setting.

Higginbottom, Pillay, and Boadu, (2013) also acknowledge the limited guidance in conducting focussed ethnographies and provide advice on how to conduct them from the earliest stage of developing the research question, through data collection and recommend the data analysis approach developed by Roper and Shapira (2000). This pragmatic approach to

ethnography with clear guidance on its conduct and analysis appeared to be a very suitable approach to answer the question posed by this research.

3.5.2. Criticisms of ethnography

The use of ethnography as a research method draws criticism on two fronts: researcher bias (Adler & Adler, 1998, Goldthorpe, 2000) and an apparently unstructured approach (Dey, 1993). As ethnographic studies are conducted by a researcher participating in the activities of a group who interprets the meaning of these activities, it can be considered that the data is subject to inherent researcher bias. In relation to a perceived lack of structure, as with other qualitative methods, the reflexive and iterative nature of an ethnographic study allows the research to evolve as the data is collected and reviewed. This can be seen (from a positivist stance) as an unstructured approach which suggests a lack of adherence to one of the key elements of research. Reflexivity is a process used by ethnographers to acknowledge their part in the research process and to minimise any influence this may have on the interpretation of the data (Hertz, 1997).

Both criticisms of ethnography contributed to one of the previously mentioned 'moments' of qualitative research; the 'double crisis' (Denzin & Lincoln, 2003). This 'moment' suggests that construction of knowledge by an ethnographic researcher cannot be unbiased and that ethnographic research is not generalisable. These arguments have been acknowledged and considered, however it can be argued that when applying constructivist theory all knowledge is constructed by somebody and thus the construct from one individual's perspective is no less valid than that of another's who has constructed their own knowledge. A lack of a systematic approach can be defended by the use of a structured ethnographic approach developing a clear pathway to identify the changes in the research path and the cognitive process underpinning the decisions to change direction and follow a lead. In qualitative research a clear pathway is considered to be an audit trail.

3.5.3. Ethnographic challenges-Reflexivity

Reflexivity in ethnography has its supporters and critics. Reflexivity suggests that the researcher considers how their own beliefs, values and perceptions influence their research and their interpretation of the research (Gerrish & Lacey, 2006). Enthusiasts suggest that reflexivity improves the accessibility of ethnographic works (Foley, 2010), is a personal

development tool for the researcher (Watt, 2007), and helps demonstrate how the knowledge developed as the study was constructed (Hertz, 1997). Critics suggest that too much introspection can detract from the focus of the study and that discussion of the researcher's positions does not remove their effect from the results (Patai, 1994). Reflexivity in this research was used to allow the researcher to question their own knowledge and assumptions about actions and their meanings and to help to explain how knowledge was constructed throughout the research. These thoughts were captured in a diary. The diary includes thoughts and ideas following the initial observations and how concepts were developed (appendix 1k- reflective diary extracts- p156).

3.5.4. Ethnographic challenges -Truthfulness

In the initial 'moments' of research (Denzin & Lincoln, 2003) qualitative researchers felt pressured to demonstrate to the sceptical quantitative research world that their research was valid and reliable (Golfanshani, 2003) however as time has progressed this need has diminished and qualitative researchers strive less to measure their work against the quantitative values of validity and reliability. Guba (1981) and Patton (2001) argued that this process is necessary for the credibility of the work and indeed Guba (1981) suggested some terms to be used in qualitative research to map with those of quantitative research. Modern thinking suggests that this approach is un-necessary, qualitative research should stand on its own merit with an audit trail used to demonstrate the thought process of the researcher and explain the links between the research data and the emerging research concepts. The audit trail approach was first suggested by Lincoln and Guba in 1985 in order to demonstrate what they termed 'confirmability' of the research. Their work was informed by that of PhD student Halpern (1983) and used his six categories of data to suggest what should be included in an audit trail. Qualitative research is an iterative process and as a result the research evolves and changes. The researcher is required to show this process of evolvement and the alterations made in order to justify the changes. An audit trail provides information about the research steps undertaken from the start of the project to its reporting (Lincoln & Guba, 1985).

In 1983 Halpern identified six key elements which help to demonstrate the trustworthiness of qualitative research as part of an audit trail: raw data, data reduction and analysis, reconstruction and synthesis, process notes, reflexive documents and instrument development. There are arguments that audit trails add little to confirm the truthfulness of research (Cutcliffe & McKenna, 2004), though Murphy and Yielder (2010) state that the

trustworthiness of the research can only be judged by those reading the report and suggests an audit trail can be employed.

3.6. Observer/Participants

Ethnographic study presents practical difficulties for the researcher. In order to participate in the activities of the research subjects a level of trust needs to exist between the researcher and the informants (the ethnographic term for research participants-O'Reilly, 2008). There is some academic debate about the most appropriate term to be used to describe research participants (Campbell & Lassiter, 2010). The terms volunteers, subjects, study, participants and activist have all been employed each with their own specific meaning (Corrigan & Tutton, 2006). Some terms are considered to be demeaning: study and subject (Chalmers, 1999) and others are considered unrepresentative of the participant's role in the research (Corrigan & Tutton, 2006). For this ethnographic research the use of generic terms may be confusing as both the radiographers undertaking the examinations and the patients being examined could be considered to be participants, informants, subjects and volunteers. In order to avoid confusion a clear distinction was made between the radiographers and the patients by using these terms to describe them in the data collection process, if the radiographers and patients are discussed together, the group they form will be referred to as informants. The term informants was chosen over participants as despite their consent to participation in the research the patients were not the focus of the study but were the facilitators of the observation of the radiographers.

In organisational ethnographic research the researcher may be considered to be acting as a spy for management (Brewer, 2004). Informants may be cautious about the motives of a research observer, uncertain of both the research and the motivation of the researcher (Hammersley & Atkinson, 2007). In this research, consideration was needed of how to build social relationships with the radiographers to allow the development of trust in conducting of the research (Hammersley & Atkinson, 2007). Coffey (1999) considers the notion of 'romancing the field' a courtship process which allows the ethnographer to build, maintain and leave relationships with the informants. This relationship was important as without a level of trust many of the radiographers may have chosen not to participate in the research. As a researcher I can be considered a learner, the knowledge shared by the study group was

used to inform my research and I learned from them (Solomon, Boud, Leontios, Staron, 2001). If as a researcher I wished to learn by joining the community I could be considered a marginal member of the group who would need to develop socially and to build trust to become a full participant in the community (Wenger, 1998, Hammersley & Atkinson, 2003). As a qualitative researcher developing new knowledge I needed to develop the social engagements required to help me be recognised as a member of the group and learn from them. In order to learn from the group as a researcher I needed to find a way to be accepted. Despite this need to build relationships with the radiographers, as a radiographer having worked in this local area it was important that the staff at the sites where the research was conducted were not personal friends. Olesen and Whittaker (1968) warn of the difficulties in conducting research amongst personal friends and suggest that this may restrict the research and introduce bias.

To help build research relationships Deiters (2011) suggests that understanding the 'cultural language' can help students gain entry into the society. As a researcher and lecturer I used my professional knowledge (see appendix 1a page138 for further information about this researcher) to gain entry to and acceptance by the group of radiographers I wished to observe and interview. I also initially befriended other peripheral members of the community, health care assistants, assistant practitioners and administrative staff. As a researcher and lecturer in radiography I needed also to be aware of my professional status. Appearing as learner within the group might have seemed incongruous with my role as a teacher. Careful explanation of my role as a researcher to those within the group as I learnt from them helped to dispel this suggestion of incongruity e.g. explaining that I cannot assume that people act the way they do for the same reasons that I would (Spradley, 1979) and thus not assuming understanding but questioning routine occurrences.

Landsberger's research (1958) suggests that observation can change the behaviour of those being studied. This type of behaviour change is known as the Hawthorne effect (Landsberger, 1958) and has been noted in observational studies undertaken in clinical practice (McCarney et al., 2007). Those under observation change their behaviour in order to please the researcher or portray good practice by improving their behaviour (Kohli et al., 2009). This however is a controversial suggestion as later studies re-visiting Landsberger's data have found other explanations for the change in behaviour. Parsons (1974) and Rice (1982) suggest that it does not occur as a result of observation but of learning from feedback (Parsons, 1974) and that its

persistence in research literature is a myth (Rice, 1982). Rather it might be considered that the change in behaviour is due to the demand effect (Nichols & Maner, 2008). The demand effect suggests that research participants either attempt to behave in a way they think will confirm the research hypothesis, behave in a way they think will please the researcher or tries to confound the results to undermine the study (Weber & Cook, 1972). These effects are chiefly reported in experimental studies. As this study was intended to investigate what was occurring in practice rather than to test an existing hypothesis these behaviours were unlikely to occur.

In ethnography the prolonged time spent gathering the data and the relationships developed during the process are considered to be "immersion in the field" (Adler & Adler, 1998). As a radiographer examining a radiographic culture I could be considered to be taking an emic approach gathering the data from an insider's perspective (Creswell, 1998) but I would need interpretive skills to understand the actions of the informants. This could also present difficulties as an insider may not recognise activities which are common place but are worthy of note for the research, however while the process of problem-solving is common place there is no understanding of radiographer problem solving and therefore every element related to the problem was considered to ensure important data was not omitted.

3.7. Research method strategy

As previously discussed ethnography typically employs, observation and interview to gather the data for the research (Hammersley & Atkinson, 2007, Brewer, 2000, Silverman, 2010). Consideration was needed as to how these elements of the data collection were to be conducted, but the first step was to identify the study site and informants.

3.7.1. Research sample

In ethnographic studies the context or site of the study is often as important as the informants within the study (Hammersley & Atkinson, 2007). It is clear that in order to investigate the actions of radiographers the context of the research would need to be the site or sites within which they practice their profession. This means that the research needed to be conducted at a place where patients were imaged for trauma injuries. These sites are not generally community based but are departments within hospitals. Locally there are two small community based imaging departments but these sites have very small staffing numbers and

have a limited workload, imaging only a few very minor trauma cases. For these reasons it was decided that the research should be conducted in imaging departments within hospitals.
Being in full time employment and with a young family it was necessary to select a hospital site or sites which were within a practical travelling distance allowing more time to be spent gathering as much data as possible rather than travelling to gather the data. Hammersely and Atkinson (2003) suggest that pragmatic issues such as geographical proximity and travel expenses often influence the selection of sites for ethnographic studies. Being the clinical education lead for undergraduate radiography meant that I was known in my role as a lecturer at many hospitals within the North West and therefore visiting a site where I was not recognised as a radiography lecturer was not possible and travel beyond the region would potentially restrict the opportunities for data collection. Also having trained and been employed in some local hospitals I was known there on a professional and personal level. Mindful of the advice of Olesen and Whittaker (1968) an approach was made to potential sites of research where I had not been employed and had no close friends working in the department but that were close enough to home and work to allow easy travel access and short travel times. A multisite National Health Service Trust was identified within easy access of both home and work and a tentative approach was made to the management team to enquire if they might be amenable to such a study being conducted within their sites. Hammersley and Atkinson (2007) refer to this tentative approach as "*casing the joint*". It was decided to conduct the research at two sites to allow a larger number of potential participants and to allow one site to be considered a pilot site. Van Teijlingen, Rennie, Hundley and Graham (2001) explain the importance of pilot studies in good research design. Pilot studies allow the researcher to test the feasibility and practicality of the project data collection and appropriateness of the research tools while allowing them to estimate when data saturation might be reached and thus estimate sample size.

3.7.2. Research sample size

In qualitative research there are no set figures for sample sizes as saturation of the data is considered to be the indicator for when data collection is sufficient (Glaser & Strauss, 1967) however too small a sample size may not capture all the actions or perceptions of the group (Mason, 2010). Authors have suggested that having a smaller sample group who are homogenous (Guest, Bunce, Johnson, 2006) or share cultural expertise (Romney, Batchelder, Weller, 1986) allow early data saturation. Guest, Bunce and Johnson (2006), conducted 60

interviews but had achieved almost complete data saturation after 6 interviews having identified 34 of the overall 36 themes. The group under study for the purposes of understanding radiographer problem solving could be considered to share cultural expertise but it could not be known whether they used similar skills when problem solving and thus an overall sample size was not set but data saturation was used to identify when sufficient data had been collected in line with the majority of qualitative studies. With considerations of sample size in mind it was necessary to consider the sample overall.

3.7.3. Research informant sampling

Qualitative research employs non probability sampling since it is not concerned with the numerical representation of the population required when intending to generalise the study, as for quantitative studies (Mays & Pope, 1995). There are several types of non-probability sampling: convenience, snowball, quota, theoretical and purposive. Convenience sampling includes informants because they happen to be available when the study was conducted (Marshall, 1996). Snowball sampling uses contacts given by initial informants to suggest further subjects for study (Berg, 2006). Quota sampling is used to select a particular predetermined number of informants from subgroups. This type of sampling may introduce bias as a result of errors in sampling and the fact that the sample is not random but is useful when statistically accurate data is not necessary (Dodge, 2003). Theoretical sampling selects informants to compare with a pre-existing study (Glaser & Strauss, 1967). Purposive sampling selects informants who would be appropriate for the study (Patton, 2001). Not all of these types of sampling were suitable for this research. The research was to be conducted in an imaging department and not all the staff in the department were radiographers. Staff that were professionally qualified as Diagnostic Radiographers- a protected title (HCPC, 2015) were the informants for the project. Other staff members are employed in imaging departments to undertake a limited range of examinations. These staff, Assistant Practitioners (SCOR, 2005), were not included in this research as their scope of practice did not include patients with traumatic injuries and observation of this patient group was integral to the research. Student radiographers act in a similar role to that of Assistant Practitioners under the direction and supervision of Radiographers and are not autonomous in their practice and therefore were excluded from the research. Staff employed in ancillary roles, e.g. administrators, porters etc. were excluded from the research as they do not image patients. This means that it was necessary to employ purposive sampling for the research to ensure

only radiographers were invited to participate. All the radiographers at the sites were invited to participate in the research in order that it would be representative of the population of radiographers with a mixture of ages, experience, gender and length of qualification. Purposive sampling was also employed when selecting which patient examinations to observe as patients attend imaging departments for a variety of imaging procedures but only those patients being imaged for appendicular trauma examinations were included in the research.

3.8. Ethical approval

Ethical approval is necessary for all research. Ethical approval is intended to ensure that the rights and dignity of research participants are maintained during a research study (http://www.nres.nhs.uk/) and that no harm comes to study participants. The Nuremberg Code was developed following the trials conducted after World War Two. These trials examined the medical experiments conducted on prisoners during the war. The code developed 10 key points the main being that the participant should consent to being part of the procedure (United States Government Printing Office, 1949). The Helsinki Declaration (World Medical Association, 2008) developed from the Nuremburg code provides a set of ethical principles which should be adhered to when conducting medical research. These principles are developed primarily for medical interventions but many of them can be applied to none medical research.

3.8.1. University ethical approval

Ethical approval was sought from the University Research, Innovation and Academic Engagement Ethical Approval Panel to conduct an ethnographic study in two hospital imaging departments. This requires completion of a detailed application form and review by a committee. This process ensures that the research is ethical but also provides helpful feedback to the researcher on their research plan and helps them to focus on the study methodology. After minor amendments related to consent and confidentiality University ethical approval was given (study number-HSCR11/09).

3.8.2. National Research Ethics Service

The National Research Ethics Service (NRES) provides advice on research ethics and provides an online application system for researchers wishing to undertake research within the National Health Service. Advice from this website suggested that full (NRES) ethical approval was not required for the conduct of this research as it appeared to be service evaluation. After consultation with a local research ethics committee (NRES Committee North West-Greater Manchester North) a multisite hospital trust was approached and research approval gained from the trust's research and development department (Approval letter 12RECNA13). Following Clinical Good Practice training and receipt of a letter of access a meeting was arranged with the imaging department managers at each site. The project was explained to the managers and a date arranged to introduce the project to the staff. At this meeting my role as a researcher within the department was also discussed.

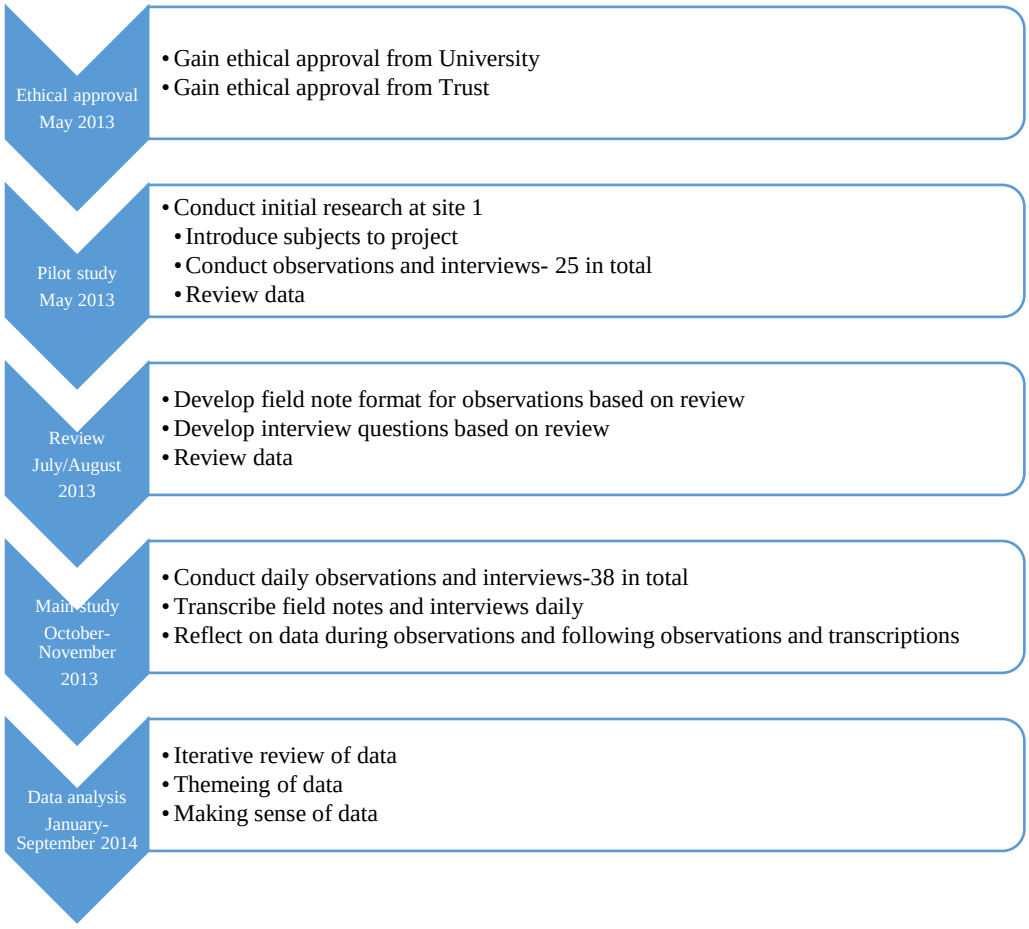
3.9. Researcher in clinical practice

At the meeting with the department managers it was important that I defined my role in the departments. It was key that I was seen as a researcher and not a practitioner (as I was observing not participating in the examinations) and it was agreed that I would not wear uniform but would wear suitable modest smart/casual clothing which complied with infection prevention measures (not extending below the elbow) and that my hair would be tied back. In this way the boundary between practitioner and researcher could be visually identified and neither staff nor patients would expect me to act in a clinical role. This visual barrier might seem to be a contradiction to the need to develop relationships with the staff but it was necessary to clearly delineate my role from a patient safety perspective. Despite being a radiographer I was unfamiliar with the emergency procedures for the sites I was working in. Had I been in uniform staff may have assumed I could act as a patient escort when they reviewed their images and act appropriately should a patient collapse. By providing a visual signal of my role as a researcher and not a staff member this distinction would be clear but would not prevent me from developing relationships with the informants. A timetable for attendance was drawn up and agreed with the department managers at each site ensuring practice would be observed at different phases of the working day to reflect varying contexts for problem solving i.e. in the middle of the day when the department was busy and fully staffed as well as during the evenings and weekends when work flow might be reduced and staff levels were lower. In his early study of radiographer decision making Bowman (1990)

identified that context was influential in radiographer decision making and thus the varying contexts for problem- solving needed inclusion within the research. The attendance schedule was displayed in staff working areas.

Alongside these agreements I worked with the managers to devise a plan of action should I observe unsafe or unprofessional practice while undertaking the observations.
The radiography staff were then approached to inform them of the research project and invite them to volunteer to participate by gaining informed consent. Figure 7 illustrates the plan for the method

Figure 7. Plan for implementation of the method



3.9.1 Observer fatigue

Martin and Bateson (2004) tell us that if observations are lengthy the ability of the observer to accurately record the events deteriorates due to fatigue and a loss of concentration. As a sole researcher with no team to allow shared responsibility for observations this was something I needed to be conscious of. This would be of particular importance when

observing in the evenings and at weekends when a working day or week had already been completed.

3.10. Pilot study

A pilot study was undertaken at the smaller of the two trust sites.

3.10.1. Introducing informants to the research

The radiographers were spoken to in their working area, the project was introduced and any questions they had were answered. Those radiographers willing to participate in the research were asked to read the introductory letter and provide demographic data about sex, age, qualifications, and length of experience and sign a consent form (see appendix 1b page 136) which was countersigned by the researcher. The data relating to additional qualifications and length of experience was collected as experience and additional training may impact upon how radiographers' problem solve and make decisions (Benner, 1984).

As a radiographer and a member of a profession, it is not possible to stand by and watch unprofessional behaviour without comment (HCPC, 2013). The dual role of the researcher within their own field was discussed by Roberts (2007) and Cudmore and Sondermeyer (2007) and the difficulty of drawing professional and research boundaries was acknowledged in their work. Radiographers have a duty of care to the patient and this cannot be overwritten by the role of the researcher. It was necessary to make this transparent to the radiographers and a process was put in place to allow concerns about any observed unprofessional behaviour to be discussed with the department manager if necessary. This process was documented within the ethics application and was included in the information letter provided when individual consent was sought. The radiographers were asked to read the individual informant information, and having consented to participate in the research, sign the consent form and were given a participant number (appendix 1b page 142). The signed consent documents were subsequently kept in a locked filing cabinet to maintain confidentiality in alignment with the Data Protection Act 1998.

3.10.2. Patient informants

For the purpose of the research it was necessary to observe radiographers undertaking examinations of hospital patients. This was also considered as part of the ethics application to

the University and the Trust. Patients were advised of the presence of the researcher via notices placed on the doors of the rooms in which the researcher was observing practice (see appendix 1c page 146). On entering the room the radiographer explained the presence of the researcher to the patient and verbal consent was sought for the researcher to observe the examination. Where an interpreter was required the request was made through them. If the patient was unable to consent due to age the guardian/carer for the patient was asked for consent to the observation. No adult patients were encountered who did not have capacity to consent to the observation. Only patients who were to be imaged following appendicular trauma formed part of the research.

3.10.3. Implementation of pilot study

The data was collected according to the suggested schedule and employing the described data collection methods.

3.11. Data collection methods

In line with focused ethnographic studies observation of practice and semi-structured interviews were used to gather the data (Cruz & Higginbottom, 2013).

3.11.1. Observations of practice

Visits to the sites were typically scheduled for four or eight hour blocks of time. Within these scheduled hours I observed as many appropriate examinations as possible that were conducted by the radiographers who had consented to participate (25 observations of 5 participants). On receipt of a request for a suitable examination the radiographer was observed: reviewing the request card and preparing for the examination, then conducting the examination, reviewing the images and discharging the patient this ensured that a complete examination was observed. Field notes were recorded contemporaneously using a pen and note pad. Upon commencement of the observation the radiographers' unique participant number and an observation number were recorded on the field notes. The radiographer informant asked the patient informant for their consent to my observation. Notes were made of the patients' injury and requested examination. No details of patient identification or date of examination were recorded for confidentiality purposes. Notes were also added about the imaging room being used: layout, equipment within etc. The actions of the radiographer were

then recorded. Actions of particular interest such as a variation in practice or an action which needed explanation were highlighted by means of adding a star to the notes adjacent to the written comment.

Field notes were transcribed at the end of each period of data collection (Appendix 1e page 148), the written material stored in a locked filling cabinet and the transcribed notes in a password protected computer in accordance with ethical considerations of data protection and confidentiality.

3.11.2. Post – observation interview

When the examination of a patient was completed and the patient discharged the radiographer was asked to immediately participate in a short interview. The interview was conducted in a quiet area away from colleagues and without hindering the work flow. Amongst his recommendations for interview techniques McNamara (2009) suggests finding an interview site away from distractions. The questions were based on the observations made during the examination and items identified as being of particular interest during the observation were also questioned to gain more insight into the actions. Questions asked varied based upon the actions observed and the number of observations previously undertaken with the radiographer (see appendix 1g page 150 for illustration of this). Questions which had been asked previously were not necessarily repeated following every observation of that radiographer. The interviews typically lasted 2-5 minutes. The interviews were audio recorded with the aid of a hand held digital recorder and the radiographer's participant number as well as the observation number were recorded at the commencement of the interview. The audio recordings were transcribed following each site visit, the files deleted from the audio recorder and the transcribed interview stored on a password protected computer in accordance with the Data Protection Act (1998). The pilot study was conducted over twenty one hours undertaken during four days at site 1.

3.12. Review of the pilot study and data collected

A review of the pilot study was conducted and the sample data was evaluated to inform the main research and identify any developmental requirements.

3.12.1. Review of method

The method employed in the pilot study proved satisfactory. It was acceptable to the informants and departmental managers and was practicable for the researcher. Data was gathered which was suitable to be used to address the research question and so it was un-adapted when implemented at the second site.

3.12.2. Review of field notes

Initial collection of field notes was limited to a few scant comments about the observation (see appendix 1e page 148 for early field notes) but with daily transcription and reflection upon the data collected, a more systematic and comprehensive note taking structure evolved which ensured that all relevant data was collected (see appendix 1f page 149 for systematic field notes).

3.12.3. Review of interview questions

During the pilot study it became evident that more focussed questions were needed to help the informants provide explanations and answers (see appendix 1g page 150 for earlier interview transcriptions). Upon questioning the radiographers about their actions it became clear that many of their behaviours were subconscious and as a result they often found it difficult to answer generalised descriptive questions (Spradley, 1979). Using focussed questioning and closed questions can be detrimental to gathering the rich data required of qualitative research and can introduce bias by narrowing the choice options when answering questions. In this case however focussed questions would be helpful. Spradley (1979) described a range of questioning techniques which can be employed in an ethnographic interview, some of which were focussed. A wider range of questions were developed to include descriptive, structural and contrast questions to help the informants explain their actions and rationale for them (Spradley, 1979) (see appendix 1h page 151 for later interview transcriptions).

3.12.4. Review of data

Review of the data started to provide some insight into the problem-solving and decision-making process undertaken when deciding how much to move a patient for imaging purposes and it also became evident that radiographers were using artefacts such as imaging request cards to support these cognitive processes and actions. In the main study it would be

necessary to consider and document the review of artefacts. During the pilot study key insights were developed which shaped both the interview questions and the data analysis. For example observation of a radiographer (study 2) greeting the patient at reception gave rise to the concept of assessment (see appendix 1k reflective diary entry date 14.05.12 p149)

3.12.5. Examination of the artefacts

The use of artefacts within a culture can be overlooked in ethnographic studies. Artefacts are constructed and used within cultures to solve problems and meet needs. They often form a part in social interactions (Hammersley & Atkinson, 2007). Artefacts within ethnography can include the equipment used, documents used and produced and digital technology. Strudwick (2014) noted in her study that the images that a radiographer produces are artefacts of the profession but the images produced are not a consideration in this research, however the pilot study revealed that within the main study the imaging request cards needed to be considered as artefacts.

3.13. Main study

The main study was conducted using the techniques employed in the pilot study, based on the review of the pilot study more structured field notes were collected and more direct questions were used in the interviews. Radiographers at site two were invited to participate in the research, a schedule of attendance was drawn up (see appendix 1i page 153) and the research undertaken. The artefacts used by the informants were also noted and examined. A table of the number of radiographers, their demographics can be found in appendix 1j page 155.

3.13.1. The imaging equipment

There were two types of imaging equipment available in the two sites with both direct digital (DR) and computed radiography (CR) machines. Each room had an individual layout depending upon the entry point and space constraints. The layout of all the rooms was examined and documented and the type of equipment within the rooms was also noted, DR or CR. The relationship of the rooms to other nearby departments or facilities was also captured.

3.13.2. Request card

Under Ionising Radiation (Medical Exposure) Regulations 2000, the legislation which governs the use of radiation for imaging purposes, a radiographer/practitioner must take responsibility for the dose of radiation they use when imaging a patient. The request card must be reviewed by a practitioner to assure the radiographer that the examination is justified. This document is the first point of contact between the radiographer and the patient and contains information about the patient, their injury and the examination to be undertaken. The review of the request card forms part of the imaging examination and it was necessary to consider the request card to be an artefact of the radiography profession. It is relevant to the problem-solving and decision-making process and is discussed in chapter 4.

3.13.3. The digital images

These 'virtual artefacts' (Hammersley & Atkinson, 2007) formed part of the research but it was not the images themselves and the detail of the body parts they imaged that was of interest but the immediacy of their availability and their review which was of interest in this research, they were therefore not considered as artefacts in this research. The images were used by the radiographer to decide if further projections were needed or if sufficient detail was provided by the images. The decision to repeat an image may have been related to the positioning of the patient and the need to move them or the equipment further and where this was the case it was noted in the observation and interview.

3.13.4. Reflections on the research process

Alongside the field notes gathered during the data collection process, thoughts and reflections on the research process and data gathered were noted during the observations and post interview and transcribed at the same time as the field notes. During transcription of the field notes and interviews, ideas and reflections were captured in word documents (see appendix 1k page 156 for reflective diary extracts). The iterative and reflexive nature of ethnographic study means that these reflections informed the development of the research (Hertz, 1997). Reflections were also noted at various stages as the research was being written up for review by supervisors or for assessments. These reflections could be used to help demonstrate the 'truthfulness' or 'confirmability' of the research (Cutliffe & Mckenna, 2004, Lincoln & Guba, 1985) and used as evidence for an audit trail (Halpern, 1993).

3.14. Data analysis

As discussed previously data analysis is not a phase that follows data collection in qualitative research, rather the analysis starts as soon as the first data is gathered (Thorne, 2003). The data is reviewed so that ideas emerge as the data is collected and themes can be explored during further observations and interviews (Creswell, 2002). It is clear that how the data is interpreted will influence the findings of the research and will be influenced by the person undertaking the analysis. The purpose of qualitative data analysis is to allow patterns, themes and understandings to be developed (Patton, 2001). Roper and Shapira (2000) provide five steps in focussed ethnography data analysis: coding for description, sorting to identify patterns, identify outliers, generalising the data to develop theories, and memoing to include reflections.

The results are derived from data gathered from 63 observations in the practice setting and 62 subsequent post-observation semi-structured interviews. Only 62 interviews were recorded since one radiographer was too nervous to answer any questions after the first observation. The data was reviewed with a grounded approach to identify emergent themes.

The field notes were transcribed on the day of collection. This was important as it allowed me to record the events while I could recall them clearly, which made it easier to read and understand the notes made and allowed me to relate them to their context (Bernard, 2006). It also provided the opportunity for reflection on the observations (Mezirow, 1994, Schön 1983), to help me understand what was happening and to allow me to pursue points of interest in the following observations. The hand written records were transcribed into Microsoft Word documents with the file named as the radiographer number. Subsequent field note observations for each examination were transcribed into a similar document with the episode of observation noted as a study number.

The interview data was transcribed verbatim from the digital audio recordings with the inclusion of timed pauses in the conversation which helped with the understanding of the context of the statement. This is a naturalistic approach to transcription (Schegloff, 1997). Oliver, Serovich & Mason (2005) tell us there are critics of this type of transcription which can reveal detail about anonymised informants e.g. ethnicity and social class, can be revealed by the expression of the informants, however naturalistic transcription was used to allow the ‘true voice’ of the participant to be heard and to avoid any misrepresentation.

This was applied to both the speech of the participant and the questions of the researcher. Indications of nonverbal communication were not included in the transcription as they did not add to the discussion and they were not recorded at the time of interview (Bailey, 2008, Davidson, 2009). Kraus (1998) tells us that hand gestures do not always indicate unspoken words but are used to help word retrieval when producing coherent speech. It would be difficult for the untrained observer to differentiate between gestures which indicate unspoken words and those that aid word retrieval. To preserve confidentiality phrases which might identify the sex of the patient have been replaced in the direct data quotes with generic terms: them, their etc.

The data was then analysed using the Roper and Shapira (2000) model for focussed ethnographic data. No modifications had been made to the research process following the pilot study and the data from the pilot study was included in the analysis. The data was coded. Categorisation required reading and re-reading of the data for immersion in the data (Denzin & Lincoln, 2003) to allow the generation of initial codes. A code is a short phrase that summarises the content of the section of data being reviewed and the initial phase of coding is known as open coding (Foss & Waters, 2003). Conventional content analysis was used (Hseih & Shannon, 2012). This method (conventional analysis) allowed the codes to be generated from the data collected and is considered to be an inductive rather than deductive approach (Spencer, Ritchie & O'Connor, 2004). Hsieh and Shannon (2012) identify two other forms of analysis: directed and summative. Directed analysis uses an existing theory to guide coding of the data, summative analysis uses counting of the use of key words and concepts. Neither of these methods were considered suitable for this research. Directed analysis seeks to match the data to an existing theory. At present this area of radiographer practice has no existing theory. Directed analysis would therefore require selection of one theory from all the pre-existing problem-solving theory models and this might prevent recognition of other models of problem-solving employed in practice. Using summative analysis places value on the frequency of repetition of key words and in the context of this research where it was possible that a radiographer might only be observed once a lack of repetition of their comments might allow the loss of a significant outcome because it was not repeated e.g. study 24 made an insightful comment about the culture of the department which is not mentioned during other observations and interviews nor repeated by study 24. The electronic files transcribed from the observational and interview data were printed onto paper and items of interest within the transcripts were highlighted using different coloured pens and

pencils. Other methods of reviewing the data were explored including the use of data management software NVIVIO however this type of data management did not suit my learning style or provide the flexibility of access provided by paper copies. These items were the given short names or phrases and these were the codes. Visual identification of the codes helped identify trends and themes within the data.

This is the second phase of analysis: sorting for patterns (Roper & Shapira, 2010). The codes within the observational data, which related to the examinations, demonstrated themes of practical behaviour and problem-solving skills. The latter also being evident in the interview data. Semantic and latent themes were identified from the data; the researcher identified themes transparent and explicit within the data (semantic) but also used interpretation of the data to identify latent themes which demonstrated underlying patterns and behaviours (Boyatzis, 1998, Braun & Clarke, 2006). Latent themes are developed inductively and arise from the understanding of the researcher. These were informed by key observations in practice e.g. assessment of the patient, (see appendix 1k - reflective diary extracts, entry date 14.05.12 page 156 and 17.06.14. page 157) the importance of experience, (see appendix 1k- reflective diary extracts, entry date 15.05.12 p156). Brewer (2000) tells us that ethnographers can use this type of analysis but should recognise that this is their understanding of the data and others may interpret the data differently.

The third stage in the analytical model developed by Roper and Shapira (2010) is to identify any outliers to the study. Outliers are any participants or codes which do not fit within the themes identified. By exploring the outliers a better understanding of the more routine behaviours and activities can be gained. Evidence of an outlier occurred early in the research and this information was used for comparison in subsequent observations and interviews e.g. study 2 appeared to be risk averse behaving differently when conducting examinations and when questioned at interview provided an explanation for this.

The fourth stage in the analysis is to construct links between the inter-related concepts to allow explanation of what is occurring and relate this to the interpretation of the researcher.
Colour coding of the data codes demonstrated a visible change in behaviours between examinations and this appeared to be related to the complexity of the examination (see appendix 1k- reflective diary extracts, entry date 01.07.14 p157). To help demonstrate the concepts and links between them the data was tabulated. The observation codes were

tabulated examination by examination for each radiographer observed (see appendix 2 Table 2a page 158). Having tabulated the observational data information from the interview data was then included, linking the cognitive themes to the practical themes identified in the observational data. This was done to explore whether there was a link between the complexity of the examination and the conscious and subconscious problem solving discussed at interview. Foss and Waters (2003) tell us that these tables can be considered as conceptual schema tying the data together to help answer the research questions. Tabulation of the data can also be considered to be triangulation as it presented the data visually and numerically to allow confirmation of the themes which were appearing from the observations and interviews (Denzin, 1970).

The previous elements of the Roper and Shapira (2010) model are intended to be sequential however their final element is not. This step is referred to as memoing where additional comments are noted in the transcripts as they are coded and themed and are subsequently used to help the researcher make links between the information contained within the data. The questions which arise when reviewing the data (memos) are then referred to in subsequent observations and interviews to allow expansion and further understanding of the subject. For example a memo was made when staff referred to experience which raised the question "how much experience is necessary since examining a significant number of routine cases should not take long" and this concept linked with the paper from Baird and Wells (2001) discussed in chapter 2 which examines assessment of students' clinical skills.

While the discussion above describes how the data from the observations and interviews was analysed it must be noted that examination of cultural artefacts is also required in the analysis of research data for ethnographic studies (Hammersley & Atkinson, 2007). The need to examine this document was prompted by the observations and interviews with staff who referred to the card before the examination and commented upon it during the subsequent interviews. An uncompleted radiographic request card was therefore examined in relation to the literature available and data gathered during observations and subsequent interviews on the use of the card during the problem-solving process.

3.14.1. Verification of the codes and themes

The codes and themes developed were as a result of the interpretation by the researcher, to ensure that the codes and themes developed were reproducible the raw data and codes and

themes were reviewed by the researcher's supervision team. The tabulated data codes from participants 11 and 20 were reviewed which represented over fifteen percent of the data gathered. In order to further verify the data the early findings of this unique research were presented at a peer reviewed conference (Newton-Hughes & Murphy, 2012) and an e-poster was developed in the following year presenting some of the themes identified (Newton-Hughes & Robinson, 2013). The themes and codes from the problem-solving data were then mapped to the theoretical framework which was developed from the review of the literature (P23).

3.15. Summary of the chapter

This chapter has discussed research methodology and methods and provided a clear rationale for the methods used for this research. It has described the stance of the researcher and their understanding of the construction of knowledge. The chapter has described a range of research methods and provided a rationale for the chosen method. It has described the research method; focussed ethnography, and has discussed the advantages and limitations of this type of research. It has provided detailed information about the data collection using observation and interview at two study sites. The chapter has provided detail of the data analysis, how the data was coded, themed and structured to help the researcher understand the data and address the research question. It has also provided information to explain how credibility was demonstrated through engagement with the radiographers and by verification of the codes and themes and reflection throughout the research process.

Chapter 4: Results and Discussion

4. Introduction

This chapter will consider the research findings and is structured chronologically starting with the assessment of complexity followed by conduct of the examination since this is how the activities would be undertaken in practice (with some degree of synchronicity). The discussion of the assessment process also considers the role of the imaging request card in the process. The concepts of problem-solving and experience will be considered in the discussion of the conduct of the examination and will be related to the Simon and Newel problem-solving model (1972). As discussed in the literature review a theoretical framework was used employing the first stages of the Simon and Newel (1972) problem-solving model and using other theories related to each of these steps. The chapter will also consider the potential limitations of the research and will conclude with recommendations for future study.

4.1. Description of codes and themes

The data from the field notes and interviews were transcribed as it was gathered to allow first level analysis (Fink, 2000) and to identify developing themes which were explored further in subsequent interviews and observations. Some of the themes started to emerge during the observations and interviews and some did not become evident until the transcripts were repeatedly reviewed and the researcher was immersed in the data (Silverman, 2010).

In order to develop themes and identify commonalities the data was coded. Coding helps to manage the data, to allow comparisons and help demonstrate patterns within the data (Taylor & Gibbs, 2010) and is part of the analysis process (Miles & Huberman, 1994). Coding was based on terms, phrases, and key words rather than existing concepts (Taylor & Gibbs 2010). Categories were developed from segments of the text and codes developed and defined (Creswell, 2009).

To code the data, sections of text or phrases with similar content were identified and colour coded using coloured pens. Notes or memos were added to the data as the codes were developed (Myers, 2008). Image 3 illustrates this process. If text was identified as related to more than one code all the relevant colours were applied to the text. Other qualitative data analysis tools exist including software programmes to support coding. One of these methods

was explored (NVivo) but the personal preferences of this researcher and their need for a visual summary means that a manual approach was employed. Figure 8 presents the codes identified.

Image 3. Colour coding of field note data with accompanying memos

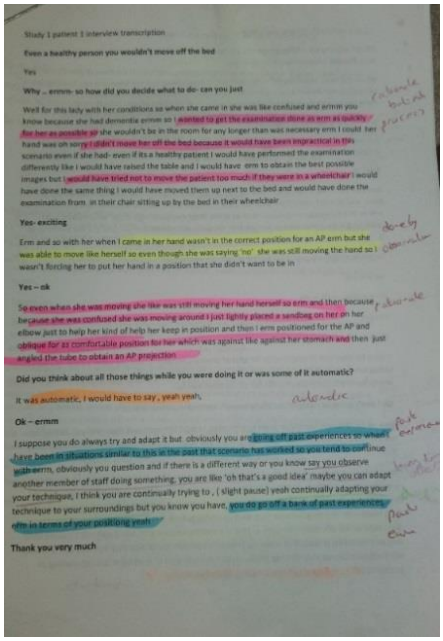


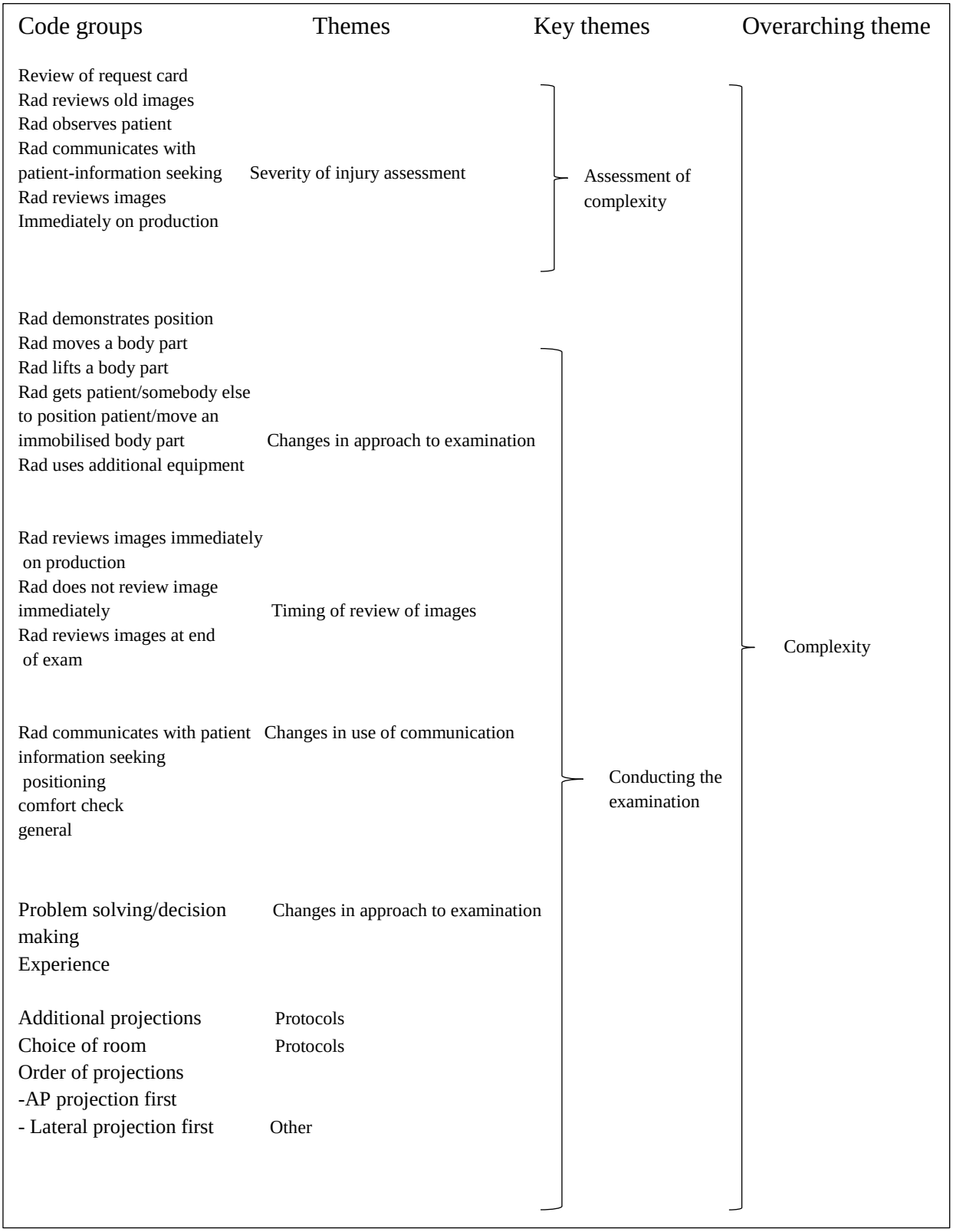
Figure 8. Codes identified from the field notes and interview data

Codes	Definition
Review of request card	Examination of request card to inform examination
Choice of room	Choice of x-ray room from 6 DR and CR rooms available and rationale for choice
Rad IDs patient	Communication for identification and justification of examination
Rad communicates with patient - information seeking	Communication used to inform justification process and or further assess patient e.g. mechanism of injury
Rad communicates with patient - positioning	Communication to aid positioning, explanation, instruction or feedback on position
Rad communicates with patient - comfort check	Communication to ensure patient comfort during positioning
Rad communicates with patient	"small talk" used to put patient at ease

- general	
Rad observes patient	Observation of patient when entering room and during the examination, includes general movements, body language and facial expressions
Rad reviews old images	Radiographer reviews images from previous examinations for additional information
Rad sets up room prior to patient entering	Radiographer sets equipment in approximate position including placing chairs or planning trolley positions
Order of projection	Whether the AP examination or lateral was the first image acquired
Rad demonstrates position	Radiographer demonstrates positioning to patient
Rad moves a body part	Radiographer manually positions body part themselves rotating and moving the limb
Rad lifts a body part	Radiographer lifts a body part themselves but does not adjust the position
Rad gets patient/somebody else to position patient/move an immobilised body part	Radiographer does not manually position the patient relying on the patient or escort to position the patient e.g. a nurse lifts the leg while the radiographer positions the image receptor
Rad uses additional equipment	Use of positioning pads, static grids, support devices
Rad reviews images immediately on production	Radiographer pauses examination to review image produced for additional information
Rad does not review image immediately	Radiographer does not pause examination but may review images before all images gathered
Rad reviews images at end of exam	Radiographer reviews all the images produced when all the images are acquired
Problem solving/decision making	Various methods the radiographer uses to solve the problems presented by the examination
Experience	Radiographer refers to experience informing problem solving
Additional projections	Images produced by the radiographer which were not requested but follow department protocols

The codes were examined and grouped and themes within the data began to emerge. For example it was clear that several of the codes related to the gathering of information about the patient. Figure 9 demonstrates the themes.

Figure 9. Themes emerging from codes



Overarching theme- Complexity

The complexity of the examination was the overarching theme from the research. The radiographers needed to evaluate the complexity of the examination in order to conduct the examination safely, ethically and professionally: to produce diagnostically acceptable images with the minimum discomfort to the patient.

Key Themes

The data revealed two key themes of assessment and conducting the examination both of which were highly influenced by the complexity of the examination (overarching theme). The data suggested that the radiographers used a multistage process to assess the patients' injury. Having assessed the patient, the complexity of the examination was estimated and the radiographers' subsequent behaviour and approach to problem solving was modified dependent upon the complexity of the examination.

4.2. Themes

It became clear from the data that there was one over-riding theme from the observations. This was the complexity of the examination. The two main subordinate themes were A) severity of injury assessment and B) conducting the examination. Both of these themes were related to the case complexity. The assessment of the patient was conducted to evaluate the complexity of the examination and the practical approach to the examination was driven by the complexity of the case. From the moment the radiographer received the request card they began to assess the patient's injury in order to understand the requirements of the examination and the ability of the patient to co-operate. The observational data revealed a complex assessment process which started with the examination of the request card and did not stop until the imaging examinations were completed. Review of the first image of the examination often added additional information that was applied before acquisition of the second image. The behaviour of the radiographer changed with the increasing complexity of the case; their practical approach changed with less manual positioning of the patient, greater use of positioning aids and more frequent review of the initial image produced. The problem-solving process varied as the complexity of the examination increased. Routine examinations required little cognitive input relying upon intuitive habitual responses to manage the examination while more complex examinations required effortful thought and cognitive input. The complexity of the case did not influence room choice between DR and CR rooms.

If a radiographer wished to review the initial images when using a CR room they paused the examination until a CR image was generated.

4.2.1. Severity of injury assessment

Observational data suggested that the assessment process fell into three phases:

i) Initial assessment/information review: information from the request and previous imaging was used to assess mobility in terms of patient presentation (walking, chair, trolley) and likelihood of injury which is based upon the imaging requested and the mechanism of injury.

ii) Assessment at introduction: The second phase of evaluation occurs when the radiographer greets the patient and brings them into the examination room.

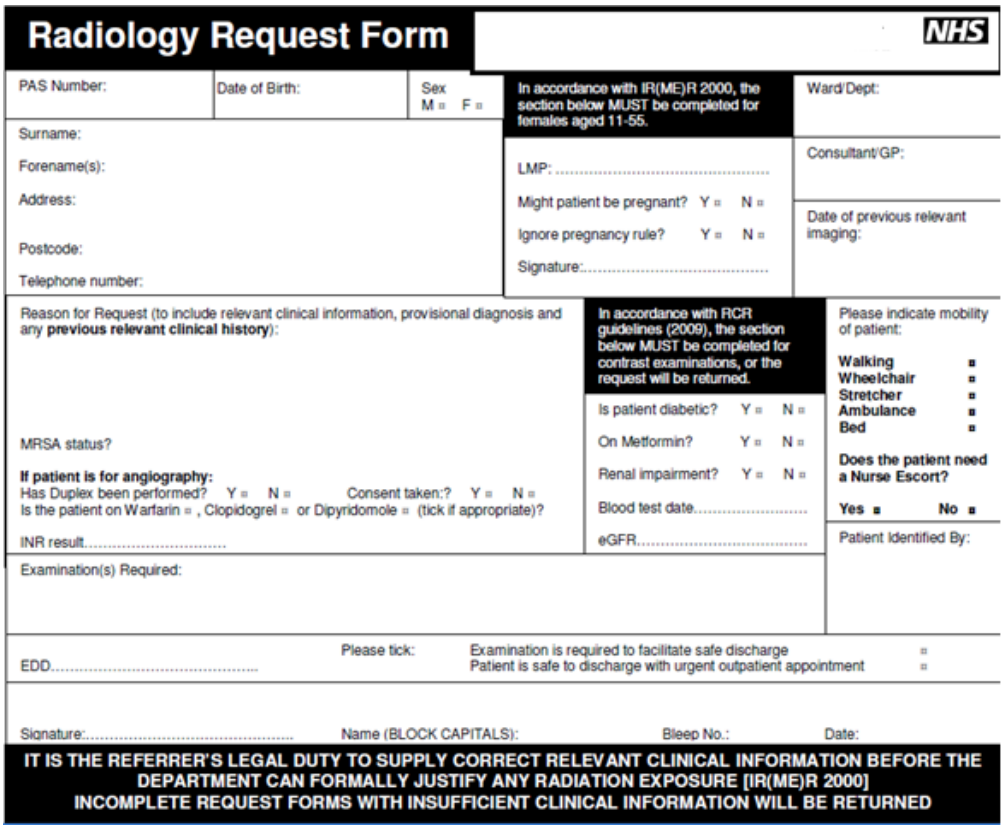
iii) Assessment during examination: Assessment of mobility during the examination included close observation of patient movement, facial expression, verbal communication and image review. These phases will be considered in detail below.

i) Initial assessment/Information review

The information review undertaken before meeting the patient was conducted initially with an examination of the request card. The request card is a cultural artefact (Hammersley & Atkinson, 2007) of the profession of radiography (Strudwick, 2014). Similar to medicine prescriptions an imaging request card is a legal document and its completion is limited to staff with appropriate qualifications and training (Human Medicines Regulations, 2012). The request card provides the information necessary for the radiographer to justify the examination under the radiation protection legislation, IR(ME)R, 2000. The card must always contain patient identification information (full name, date of birth, address), referrer information including source and referrer's name and signature. The card should provide relevant clinical history for the examination requested, the clinical question to be addressed and information about patient transport requirements (RCR, 2008). Additional information may be provided on the request card in relation to the patient's pregnancy status and any previous imaging the patient may have had. The request card is a legal document and the examination cannot be conducted without an appropriately completed request (IR(ME)R, 2000).

An example of the request card used at the research sites can be seen in figure 10a below.

Figure 10a. Example of the request card used at the research sites



Radiology Request Form NHS

PAS Number: | Date of Birth: | Sex M ▫ F ▫

In accordance with IR(ME)R 2000, the section below MUST be completed for females aged 11-55.

Ward/Dept:

Surname:

Forename(s):

Address:

Postcode:

Telephone number:

LMP: .....

Might patient be pregnant? Y ▫ N ▫

Ignore pregnancy rule? Y ▫ N ▫

Signature:.....

Consultant/GP:

Date of previous relevant imaging:

Reason for Request (to include relevant clinical information, provisional diagnosis and any **previous relevant clinical history**):

MRSA status?

If patient is for angiography:
Has Duplex been performed? Y ▫ N ▫ Consent taken:? Y ▫ N ▫
Is the patient on Warfarin ▫ , Clopidogrel ▫ or Dipyridomole ▫ (tick if appropriate)?

INR result.....

In accordance with RCR guidelines (2009), the section below MUST be completed for contrast examinations, or the request will be returned.

Is patient diabetic? Y ▫ N ▫

On Metformin? Y ▫ N ▫

Renal impairment? Y ▫ N ▫

Blood test date.....

eGFR.....

Please indicate mobility of patient:

Walking ▫
Wheelchair ▫
Stretcher ▫
Ambulance ▫
Bed ▫

Does the patient need a Nurse Escort?

Yes ▫ **No** ▫

Patient Identified By:

Examination(s) Required:

EDD.....

Please tick: Examination is required to facilitate safe discharge ▫
Patient is safe to discharge with urgent outpatient appointment ▫

Signature:..... Name (BLOCK CAPITALS): Bleep No.: Date:

IT IS THE REFERRER'S LEGAL DUTY TO SUPPLY CORRECT RELEVANT CLINICAL INFORMATION BEFORE THE DEPARTMENT CAN FORMALLY JUSTIFY ANY RADIATION EXPOSURE [IR(ME)R 2000]
INCOMPLETE REQUEST FORMS WITH INSUFFICIENT CLINICAL INFORMATION WILL BE RETURNED

Radiographers used the request card to gather information about the patient, their condition and their ability to undertake the examination. This process was chiefly informed by the age of the patient, the clinical history given, and the mode of patient transport. The request card information led the radiographers to investigate whether the patient had had previous imaging and they would review the previous images for further information which might provide information about previous positioning for similar examinations.

Quotes from the interview data suggested that this observation was correctly interpreted

"…for me a lot of the decision is made as soon as you look at the card, you look at their age, you look where they have come from…" Radiographer 19 patient 1

"*you know reviewing the previous images to give you an indication of what it is going to be like. erm I also noted on the previous one for example it was a rolled,"*

Radiographer 1 patient 5

This statement relates to the imaging of a child who had been rolled into a particular position and supported in that position by their parent, indicating that this technique may be required for this examination.

"Q. Before you got the patient in actually for this one you reviewed the images, was there something on the request card that suggested that they had got previous images or?

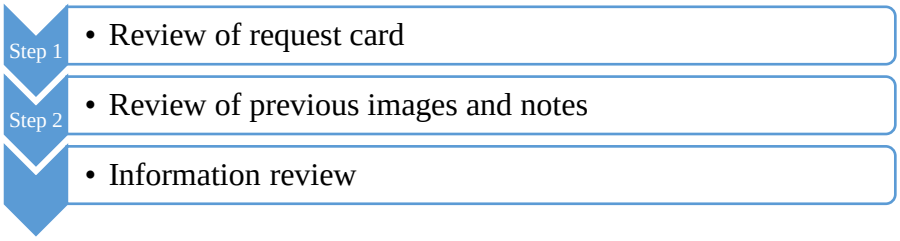
A. Yes, it said they had previously broke it and they had an internal fixation

Right ok

A. So I just wanted to see what pins they had put in." Radiographer 20 patient 7

Figure 11 below summarises the assessment of the patient when the radiographer reviews the information provided.

Figure 11. Summary of the information review process



ii) <u>Assessment at introduction</u>

This was observed when the radiographer met the patient, and happened when they called them from the waiting room or when they went to collect the patient from a waiting area because they were in a wheelchair or on a trolley. Escorting the patient into the x-ray room the radiographer used the opportunity to assess patient mood, ability to understand instructions and consciousness level. Radiographers used questioning and observation to gather more information about the mechanism of injury, level of pain experienced by the patient, mobility of the affected area and the likelihood of injury, while taking the opportunity to observe the injury site. Radiographers questioned the patients to confirm that the information contained on the request card justified the examination but frequently went on to ask further questions about mechanisms of injury, to gain more detailed information than that provided on the request card.

Interview data suggested that this observation was correctly interpreted as the radiographers frequently commented on the lack of detailed clinical information provided by the request card.

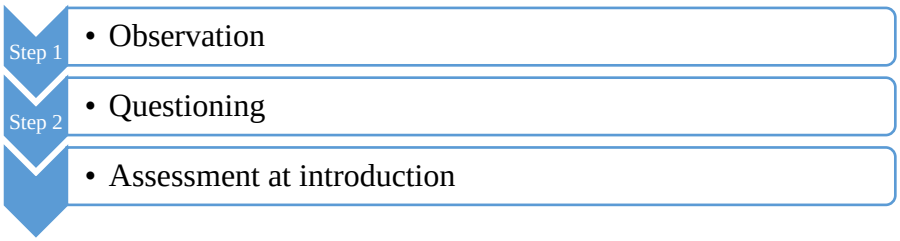
"…specifically for this request because it was such a vague request…"

Radiographer 1 patient 10

"…, they had only put twisted ankle so mechanism of injury can be really important and A and E are quite notorious at not telling you what is wrong…" Radiographer 12 patient 1

Figure 12 below summarises the assessment of the patient at introduction when they meet.

Figure 12. Summary of assessment at introduction



iii) <u>Assessment during examination</u>

This assessment was continuous throughout the examination and required close observation of the patient for visual cues about their pain level and ability to achieve the positions required. Verbal communication was used for further information gathering and for comfort checks with the patient. The radiographer listened for para-lingual expressions of pain from the patient.

Interview data confirms that communication and comfort checks were used for information gathering.

"…I was trying to assess with that point as to if there was a particular focal point of (…) if there was a particular focal point of pain and injury…" Radiographer 1 patient 10

"…I was trying to find a little bit more about what had happened…"

Radiographer 11 patient 2

For routine (straightforward) examinations radiographers infrequently reviewed the first image they produced unless they were using a DR room. When using a DR room for these

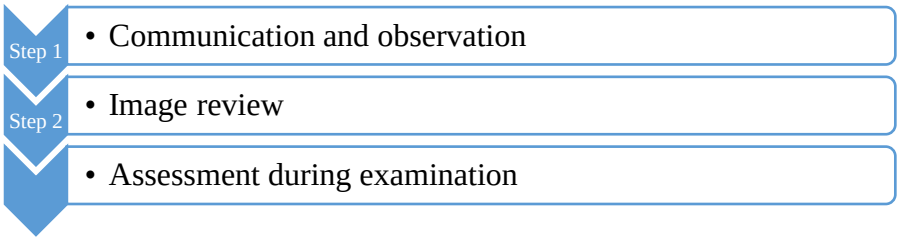
examinations the review of the first image was not necessarily to inform the assessment process but was also used to ensure room functionality. Interview data confirmed this.

"*…erm after first image it might be battery flat or whatever so…*" Radiographer 15 patient 3

When the complexity of the examination increased radiographers more frequently reviewed the first image produced to provide additional information to support the problem-solving process.

It might be assumed that radiographers consciously wishing to gather more information about patient injury would chose to use a room which allowed immediate viewing of the first image produced (a DR room) to gain more information before moving the patient for a second examination but this was not evident from the data. However it is clear that review of the first image produced happened more routinely when using DR imaging equipment. Review of the first image was done intentionally during complex cases when using a CR room by deliberately pausing the examination to process and review an image before continuing with further projections. Figure 13 below summarises the assessment during the examination.

Figure 13. Summary of assessment during examination



This data provides an in-depth and unique description of the patient assessment processes in which radiographers engage during an x-ray examination. This has never been captured before. The process can be readily constructed within a model for radiography practice (Newton-Hughes & Robinson, 2013).

An example of how the model might appear in practice could be described as: radiographer reviews request card and identifies information of key importance to the examination, presentation (trolley, chair, etc.), age, and area of injury. The radiographer selects a room and appropriate equipment then calls the patient from the waiting room, watching as they come to the examination room door, looking for signs of movement limitation, patient demeanour and capacity to co-operate. The radiographer questions the patient to gain more information in relation to the severity of the injury and then begins the examination. During the initial

positioning the radiographer observes the patient behaviour and facial expression while listening to the patient. The radiographer sometimes intentionally reviews the first image produced to provide more information to guide positioning for the second image.

Having assessed the patient the radiographer must then conduct the examination. Their approach to the examination varied as the complexity of the examination increased.

4.3. Development of a measure of complexity

Using colour for coding the data gave a clear visual indication of changes in the practice of the radiographer. This visual signal suggested that the radiographers' behaviour/practice changed using different skills dependent upon the complexity of the examination. For example, for more complex cases, more communication for comfort checking was used, the radiographers were less inclined to move the patient and asked the patient to move themselves or got assistance from an escort. This change was not identified iteratively during the observations and transcriptions but was identified when the data was collated and themed.

In order to confirm this finding it was necessary to identify the complexity of the examinations observed and explore any changes in the conduct of the examination. Within radiography there is no classification system for examination complexity, therefore one was developed specifically for the research. This was based on the ability of the patient to comply with the positioning requirements. No literature was found which discussed patient compliance with physical examinations. A review of the literature related to patient compliance indicated that mental capacity, physical ability to move, the presentation of the patient (trolley, wheelchair, walking) and the complexity of the patient position required for imaging could be used as criteria. Jin, Sklar, Min and Cheun (2008) conducted a qualitative literature review of 102 articles investigating therapeutic compliance. Their results suggested that older and younger patients and the patients' physical ability might influence compliance with these patients being less able to comply. With aged patients the results were not unequivocal, though the work suggested impaired vision, hearing, memory and cognitive skills as being influential in compliance. Sams (2006) tells us, in his book on pain relief that patients in significant pain are less likely to comply and it is sensible to assume that patients with reduced movement capacity, either as a pre-existing condition or as a result of trauma, are less likely to be able to comply with positioning requests. The presentation of the patient was also considered as the range of movement of a patient confined to wheelchair is different

from that of one able to walk unassisted into the room with the latter having more scope for movement. Supporting this concept, Tugwell (2014) suggests that imaging a patient on a trolley can be problematic. Her radiographer respondents agreed (89%) that imaging on a trolley requires adapted technique and 77% agreed that imaging a patient on a trolley is more technically challenging. Based on these concepts the field notes for each patient were reviewed for notes about the patient presentation, age, body part and the examinations classified.

Each observed case was itemised in a table (Appendix 2a page 158). The patient characteristics (child, compliance capacity concern, complex body part, and bed/trolley/chair) were included. The table was compiled numerically starting with 'radiographer one'/'patient one' and moving through the data until all the observations were tabulated. A patient who presented with no significant potential difficulties was classed as routine. A patient with one potential difficulty was classed as intermediate complexity and a patient with more than one potential difficulty was classed as complex. The examinations were classified based on the information review and assessment at presentation (described previously). Some examinations of children could not be easily classified as it was uncertain until the examination commenced whether the child patient would understand the examination well enough to co-operate with the positioning or be composed enough to allow the examination to be routinely conducted. Their composure might also change during the examination and the radiographer may have to change their approach and communication style as recognised by the NSF "Getting the right start" (2003). Hardy (2000) tells us that examination of children is complex because of their less well developed communication skills and understanding. And Harding and Davis (2015) tell us that imaging children requires a different skill set. For these reasons paediatric cases were classified as intermediate. In order to confirm and justify the complexity classification system the data from the informant interviews was reviewed to identify whether the radiographer had commented on the complexity of the case and these comments were included in the table. The data related to the examination room and abbreviated data codes were also added to a table to confirm their presence (figure 14) and help identify themes within the observed behaviour.

Figure 14. Abbreviated codes used

M = Rad rotated/moves a body part	SO = Rad gets patient/somebody else to position patient/move an immobilised body part
SOD = Rad demonstrates position	L = Rad lifts a body part
C = Rad communicates with patient- comfort check	P = Rad uses additional equipment
I = Rad reviews images immediately on production	F = Rad reviews images at end of exam
AP= Order of projection AP/DP projection done first	LAT= Order of projection Lateral done first

The interview data was used to evaluate the level of cognitive input required by the radiographer during the examination and this information was also applied to the data table in order to evaluate whether there was a relationship between the level of complexity and the problem-solving skills required.

This table was reviewed by two other researchers. They each reviewed a different sample of the data (radiographer 11-6 observations and radiographer 20-7 observations) using the coding table and confirmed the findings.

The data table confirmed that the examinations observed varied in complexity and the application of the codes suggested that radiographers changed their approach to the examination based on the complexity of the examination.

The examinations were reclassified and displayed as routine, intermediate and complex. This allowed visual comparison of the pattern of distribution of codes according to examination complexity (See appendix 2b, Table 2 (routine) page 173, 3 (intermediate) page 177 and 4 (complex) page 181). Table 5 below summaries the incidences of the observations

Table 5. Summary of instances recorded

Complexity	**Imaging type**		**Codes**								**Cognitive Processing**	
	CR	DR	M	SO	SOD	L	C	P	I	F	Automatic	Thought-through
Routine	24	5	26	1	14	0	3	8	4	25	15	2
Intermediate	9	7	14	1	6	1	4	7	11	4	8	3
Complex	8	3	7	8	0	5	4	7	7	4	2	6

These tables provided further insight into the frequency of imaging choices and problem-solving skills within each category. The data code distribution indicated that there was a change in the behaviour of the radiographers between complexity categories but this was difficult to assess as the codes were grouped in one column in tables, 2, 3, and 4. This column was separated out to demonstrate the frequency of the codes and identify themes within the data codes (see appendix 2c -table 6 page 185). It should be noted that even though every patient examination was recorded not every one of the codes were recorded for each examination. This was in part related to the iterative nature of the data collection process. Review of the early data collected as it was transcribed prompted further questions in subsequent interviews and encouraged noting of previously unconsidered factors in field notes, hence data collected in later observations and interviews included data that was not noted in earlier studies. This categorisation system warrants further validation, notwithstanding this it served as a useful means of discussing radiographer problem solving in relation to the levels of complexity.

4.3.1. Conducting the examination in the three measures of complexity

Tables 2,3,4,5 and 6 demonstrated the differences between the behaviour of the radiographers when conducting examinations of varying complexity and these concepts will be considered further below.

4.3.2. Routine examinations

Table 6a. Summary of the data codes arranged by complexity-routine

Routine cases									
M	SO	SOD	L	C	P	I	F	AP	LAT
27/30	1/30	14/30	0/32	3/32	8/32	4/29	25/29	19/21	2/21

Table 6a provides figures to indicate the summary of number of times the data codes were observed during routine examinations.

These examinations were the majority of cases and were typified by ambulant patients who were fully able to co-operate with the examination and had not been provided with additional support by the accident and emergency staff e.g. sling to support arm injury. Review of the request card (information review) and visual assessment of the patient (assessment at introduction) indicated that the examination would not be complex and as a result very little on going assessment was demonstrated during the examination.

The majority of the examinations were conducted in the CR room, those conducted in a DR room were more likely to result in immediate image review (I). Interviews conducted following the examination revealed that radiographers selected the room based upon availability and its assigned use and were not influenced by the immediacy of image review. The following quotes refer to DR and CR rooms respectively yet the room facilities do not appear to influence choice and are not mentioned when the radiographer is asked about room selection.

"room one was free which is why I used it" Radiographer 1 patient 3

"because it is our A and E room and the other rooms were busy" Radiographer 12 patient 1

Positioning this patient group was achieved with some explanation and demonstration (SOD) and by manual positioning (M) to precisely position the limb after the patient had positioned themselves. Use of pads to support or immobilise the patient was less frequent for this category of patients and a majority of the examinations were commenced with the AP projection (AP). For most of the examinations classified as routine radiographers felt that having completed their assessment of the patient they did not require any problem solving or decision making to inform their choice of action. The observations and interview data suggested that radiographers occasionally thought through which projections to image or whether to remove jewellery which would appear on the image but for routine examinations no further cognitive input was required. Radiographers used terms such as 'habit', 'routine' and 'automatic' to describe how they conducted the examination.

"you are just literally on autopilot because you do it so often, maybe as a student you are constantly thinking but I think after years of it you just kind of slip into radiographer mode and you just start doing it"

Radiographer 19 patient 4

The quote above suggests that experience influences the behaviour of the radiographer and this was a frequently occurring theme within the data. The quote below relates to a decision about whether to remove a patient's ring for an examination.

"I think maybe when I first started I would have maybe 'uhmed' and 'ahed' a little bit over the decision the fact that having a bit more experience it just goes 'yep no fine' "

Radiographer 1 patient 7

Radiographers were not always aware that they had assessed the patient in order to conduct the examination. They also described their feelings and beliefs which influenced intuitive behaviour in these situations. They described an intuitive response to the requirements of the examination rather than a conscious reasoned approach.

"I believe the patient was able erm to perform a lateral and I just believed (they) needed to be coaxed"

Radiographer 1 patient 14

For the most part the radiographers did not review the images they produced until the examination was complete (F) and the patient had been returned to the waiting room.

It is interesting to note that the assessment of complexity system identified one patient as routine who presented as intermediate when the radiographer assessed them and found that they were unable to move their elbow for the examination (Radiographer 2 patient 5). It is also interesting to note that as indicated by the comments at interview conducting this examination required effortful thought for the radiographer which was not typical of routine examinations.

"I didn't want to disturb anything that was already going on and I did ask the patient if (they) could straighten (their) elbow, when (they) said 'no' that is when I decided to adapt technique"

Radiographer 2 patient 5

4.3.3. Intermediate examinations

Table 6b. Summary of the data codes arranged by complexity-intermediate

Intermediate cases

M	SO	SOD	L	C	P	I	F	AP	LAT
14/16	1/16	6/16	1/16	4/18	9/18	11/15	4/15	14/15	1/15

Table 6b provides figures to indicate the summary of number of times the data codes were observed during intermediate examinations.

Half of the intermediate cases were included in this section as a result of uncertainty about the patients' ability to comply; the majority of these cases being children. This uncertainty influenced the behaviour of the radiographer they were less inclined to demonstrate positioning to patients (SOD) who may be unable to understand and opted to manually position the patients (M). The remainder of patients in this classification were included as a result of the complexity of the imaging examination or their presentation and the move to manual positioning (M) was also evident for these patients with only one case relying on demonstration (SOD) alone for positioning. This may be attributed to the level of injury as assessed by the radiographer. Interpretation of this behaviour might suggest that the severity of the injury indicated that the patient might need support in attaining the appropriate position required rather than relying on demonstration alone. Table 6 intermediate cases (see appendix 2c page 185) demonstrates this change in practice between classifications of examination. Communication for comfort checks (C) was seldom used in intermediate cases but there was an increase in the use of pads to position the patient (P) with half the patients in this category having their limb supported in position with a pad. This also suggests that the radiographers feel the need to provide the patient with an additional level of support. All but one of the cases (where the information was recorded) were commenced with the AP projection with the exception of the first examination conducted by radiographer 21 where the patient presented in a sling with the arm flexed in the lateral position and the radiographer intentionally left the patient in this position then reviewed the first image produced before moving the patient (see appendix 2d page 188 for Radiographer 21 patient 1 transcription). Choice of room was to some degree influenced by this category of patients as nearly half of the patients in this group were children and site two used a dedicated DR room for paediatric examinations and would intentionally move across the site to use the paediatric room (see appendix 2e page 190 for site 2 map). This in turn influenced the review of the images which was conducted immediately (I) as they are instantly available with DR equipment but there was also a rise in immediate review of the images produced in CR rooms. At site one there was no demonstrable influence of examination complexity on room choice.

Assessment of the patient was key in intermediate examinations and radiographers made conscious efforts to assess the patient.

"…I would be constantly assessing the patient from the moment you meet them and using, using all of those cues I guess you would say to inform it"

Radiographer 1 patient 4

"…so (they) was calm, (they) was sensible (they) understood what was going to happen, and (they) was ok like I mean I made a judgement call I did make a judgement call that (they) would be fine…"

Radiographer 1 patient 4

Assessment of the patient in intermediate cases influenced the radiographers' approach to the examination in terms of problem solving.

"…I made a decision that the child was capable and competent …"

Radiographer 1 patient 9

For many patients in this group, despite the potential for intermediate complexity at information review, assessment of the patient on introduction indicated that the examination was routine, and intuitive, "automatic" problem solving was employed.

"…apart from that it was a quite routine protocol…"

Radiographer 1 patient 9

This happened primarily with the patients who were children. When assessed they were deemed capable of compliance as such it became a routine examination requiring little active cognitive input.

"…there was no requirement for any adapted technique, the patient was quite fit, erm (they) understood what I was saying to (them) … … a straight forward AP and lateral wrist…"

Radiographer 2 patient 3

Some of the cases proved to be more complex than a routine examination when the patient was assessed at introduction.

"Because (they) was, looked like (they) was guarding it a lot and it looked it more or less was the wrist as opposed to the elbow and I thought about, and that's the way (they) put (their) hand down first and I thought well rather than moving (them)…"

Radiographer 18 patient 4

Few of these examinations required some thoughtful effort. This was sometimes planning the order of the examination.

"I thought you are better off getting proper projections of the wrist in its, well PA really then getting (them) to flip (their) hand around and make (them) in pain when it is not really needed, really, plus its, for then the lateral, I was doing it in, I know on the computers it's like turning off turning on in terms of switching around the exposures and everything but in terms of the patient it is more fluent…" Radiographer 18 patient 4

As previously noted when patient 6 complained about pain radiographer 1 drew on their experience to help them decide how to position the patient. The radiographer in this observation suggests that with experience their perception of how much pain the patient is experiencing has changed. They now perceive that patients can tolerate the pain associated with positioning the patient to the required standard. It is not clear whether this is as a result of desensitising the radiographer to pain experienced by patients or because patients' report less pain than expected.

"*when I was a student and didn't have much experience I would have been hesitant to actually have continued on with say doing the axial because (they) was in pain, I maybe would have gone to an alternate view quicker like I would have on fewer patients whereas with experience I think 'oh no (they) can move that little bit extra it's not that difficult for (them)' so I will persevere"* Radiographer 1 patient 6

4.3.4. Complex examinations

Table 6c. Summary of the data codes arranged by complexity-complex

				Complex cases					
M	SO	SOD	L	C	P	I	F	AP	LAT
7/12	8/12	0/12	4/12	4/13	7/13	7/11	4/11	11/11	0/11

Table 6c provides figures to indicate the summary of number of times the data codes were observed during complex examinations.

Patients classified in this category were in the minority of cases observed and more frequently presented on a trolley than in a chair (10/13), many of these cases also had an inability to understand the examination (8/13). It was noticeable that for these examinations none of the radiographers used explanation and demonstration (SOD) to help with

positioning, they also reduced their movement of the patient (M) relying upon the patient or patient escort to lift the extremity (SO) or simply lifting the body part themselves (L) without attempting to change the presenting position of the limb. Comfort checks (C) were more frequently used for this group of patients. Radiographer 2 patient 4 illustrates this approach

"no I wasn't going to move (them) at all, I basically kept (their) arm in exactly the same position as when (they) came in the room, I just moved (their) shoulder so that I didn't disturb the elbow at all, gave (them) support, asked (them) if (they) could move it (them)self (they) could lift it but (they) wasn't able to do as I asked (them) so I actually assisted (them) physically by moving the arm"

Pads (P) were also used more frequently to support these patients in position. The majority of these examinations were conducted in CR rooms but despite this the radiographers more frequently reviewed the first image produced (I) pausing the examination to gather more information before proceeding to the next image. All of these examinations were commenced with the AP projection. Where the cognitive processes were recorded the majority required effortful thought with the exception of radiographer 1 patient 8 which the radiographer approached as a routine case but when a routine approach failed the radiographer acknowledged that more thought was required.

"yeah I just wasn't thinking for that examination actually, I probably, I wasn't think things through properly enough with all of them".

Thought through problem solving employed knowledge and experience and sometimes required trial and error.

"I decided to do the pelvis first because (they) was a query fracture of the pelvis or the hip having fallen down the stairs so you need to rule out any injury in that joint before you start trying to move legs to do ankles and feet lower down"

"Q. you couldn't move the leg, so how did you know what would work?

A…, well past knowledge, I have done it before, but you have got to think of the position that the foot is in and the position that you can then move the x-ray tube and the films in and what you can use to hold them in the certain positions"

"I think you sometimes just have to stand back, look at what you've, look at what room you are in, where, what the patient is like and also I think, probably experience as well,"

Radiographer 11 patient 6

"Q. this is my perception, is that you experimented a little bit then with how best to get that image receptor in the

A.I was playing it by ear a little bit" Radiographer 2 patient 4

4.4. Comparison of radiographers' approaches

While it can be seen that the approaches to the examinations varied as the complexity of the examinations increased it should be considered whether this is due to a radiographer's individual approach or related to the sample (this could be equated with considering variables in quantitative research) i.e. do radiographers vary their technique with increasing complexity or did different radiographers use the same technique for every category of examination which has suggested this overall result. Not every radiographer was observed more than once or for every category of examination and therefore themes within their behaviour cannot be considered, however where a radiographer was observed multiple times this data was recorded in a colour coded table to examine their behaviour (see appendix 2f page 191 for table 7). The table allowed consideration of the behaviour of each radiographer.

The table demonstrated that there was a change in behaviour for individual radiographers; they changed their behaviour slightly between routine and intermediate cases and more noticeably for complex cases. The notable exception to this was radiographer 2 who behaved more consistently between routine and intermediate examinations. Radiographer 2 relied upon explanation/demonstration and the patient positioning themselves with very tiny adjustments by the radiographer to accurately position the limbs. This was noted at the time and discussed at interview revealing a radiographer preference for patient self-positioning based on past experience.

"Q. Right ok- I have watched you twice now, you usually ask the patient to position themselves, you explain very well what you want them to do when you ask them to do that, why do you do that

Errm- long pause (3 seconds)

Q.Is unconscious or conscious or?

A. It's a habit erm pause (3 seconds) I think it's with working in, working nights and working in casualty x-ray erm you don't know, you haven't got x-ray eyes, you don't know what is going on inside there until you've seen it on an image so I just prefer myself first of

all not to to possibly disrupt any any bone fractures that may already be there and secondly not to hurt the patient if they are moving themselves then there is no danger of me actually causing them harm injury pain or being able to present legally to accuse me of assault or something similar, I feel safer asking the patient to position themselves and so therefore I have developed the words that the patient can understand mainly through doing DEXA to be honest because they were all old ladies, and their skin is very thin, you can't touch it because it tears, they are just fragile, you know so I prefer not to touch the patient if I can possibly help it

Q.OK so you think the previous experience with more fragile individuals has affected your practice

A. Definitely" Radiographer 2 patient 2

Notwithstanding this trait radiographer 2 did move the patient for a complex examination (Radiographer 2 patient 4) choosing to lift the limb rather (L) than manually position it (M). The reluctance of this radiographer to position patients manually is markedly different from that of their colleagues and makes the data gathered from these observations outliers in the data set.

The practice of radiographer one varied slightly from the majority of observations: comfort checks were used for all complexities but more often used for intermediate cases. Pads were used for some intermediate cases and more frequently for complex cases. While the use of comfort checks is atypical the remainder of the behaviours follow the pattern identified. Radiographer 3 was employed at site 1 and 2. Observations 1 and 2 were undertaken at site 1 and observations 3 and 4 were undertaken at site 2 but the radiographer's practice was similar at both sites.

Radiographer 15 conducted 3 routine examinations using manual positioning with some explanation. This radiographer employed an unusual technique for positioning the ankle placing a pad under the patients' hip to encourage internal rotation. This change in technique appears to be a personal preference adopted when imaging ankles, their more frequent use of pads making them another outlier in the data set.

"Q.I have seen you do ankle before when you have put the pad under the hip, what is that for?

Erm it naturally helps keep patient ankle in right position

Q. Oh ok

You, you can ask patient to turn that leg inwards and get that mortice view which we need, but I found it, I just thought up myself, I just found that it's much easier its naturally slightly turning leg inwards and it is always no trouble for patient so patient agrees that it helps"

Radiographer 15 Patient 3

Review of the data at this level demonstrated that the changes in approach to the examinations were not always a result of personal style/preference of individual radiographers but were as a reflection of the complexity of the examination.

4.5. The culture of problem-solving in the departments observed

While this focussed ethnography was investigating a small element of the practice of the radiographers in the departments concerned it is important to consider how this element relates to the culture as a whole. It can be seen from the record of observations that many of the examinations were conducted solely by one radiographer acting autonomously. Of the sixty three observations made only one examination witnessed was a joint endeavour with two radiographers working together in a room to solve a problem. Rather than working together radiographers were sometimes witnessed seeking advice from a colleague before commencing the examination, though this was observed on very few occasions. It seems from observation that within this culture social support in conducting the examination and problem solving in terms of positioning was considered to be an individual responsibility. A general lack of team working was noted by study 24 who said

"… its a bit different in the way they work round there because a lot of departments I have been to erm the radiographers bounce off one another, off each other so if I am doing an x-ray, someone else is running the films and they will be checking the film as well, whereas the team work isn't as much up to scratch here in my opinion"

The description provides an insight into the level of team working the radiographer has experienced previously. The description does not indicate that the teams the radiographer was accustomed to supported each other with decisions in relation to patient positioning. It describes support with tasks related to an efficient management of the examination but not advice on positioning. In one observed instance the radiographer sought support from the referring clinician rather than any colleagues when considering the positioning of a distressed and confused patient. This is likely to be because it is the referring clinician who will review

the images produced and use them to form a diagnosis for the patient. It may also have been to introduce the referring clinician to the context of the examination.

While team working did not appear to be a cultural norm in the departments where the observations were undertaken there was one clear element of cultural practice demonstrated in relation to the choice of imaging rooms. When asked why a radiographer had chosen to undertake an examination in a particular room the answer frequently related to the designation of the room as an Accident and Emergency room rather than a general room.

4.6. Review of the findings

As intended the data from the observations and interviews had clear areas of overlap as the interviews explored concepts noted from the observations. The interview data confirmed many of the findings of the observational data and added further detail to the understanding of the assessment process. It is clear from the data that the radiographers used a three stage assessment process to evaluate the complexity of the examination before and during the imaging. Following the assessment the complexity of the examination dictated how the examination was conducted. A tool for assessing complexity was developed in order to demonstrate this. Routine examinations formed the majority of the observations with fewer intermediate examinations conducted and even fewer complex examinations observed. Routine examinations required little cognitive input from the radiographer, imaging positions were demonstrated, the patients limbs positioned and communication was used to gain co-operation. The examinations were conducted in an automatic habitual fashion with no consideration given to the order of imaging. Images for these examinations were not reviewed to provide additional information for the assessment process. Radiographers used positioning pads to help patients maintain the position they had adopted. For intermediate and complex examinations the assessment process was continuous including review of images as they were produced. These examinations were often pre-planned and radiographers drew on past experience to help them solve the problem of positioning. Interestingly the rapid availability of images in a DR room did not influence room choice, radiographers opting for location and room designation over speed of image availability. Radiographers used a ‘hands off’ approach to positioning these patients in order to avoid moving them un-necessarily and exacerbating any injuries. The communication used for these examinations included less direction of the patient and more comfort checks. Review of individual radiographer behaviour confirmed that with few exceptions individual radiographers modified their

behaviour with the increasing examination complexity. It was clear that one of the professional artefacts, the request card, did not contain sufficient information to aid the assessment process and the request card needs to be considered further.

The implications of these findings and their relation to current theory will be discussed in the following sections. The aim of this research was to evaluate the problem solving undertaken by the radiographer when positioning the patient. When the radiographer receives the request card they are presented with an ill-defined or semi structured problem (Hardin, 2002, Van Grundy, 1981). Problem solving can be difficult when the situation is new, there are insufficient resources, ambiguity and uncertainty and a lack of skills (D'Zurilla, Nezu, Maydeu-Olivares, 2004). Radiographers are well trained and well-resourced in the clinical setting and the difficulties in positioning the patient are as a result of the novelty of the situation and the ambiguity and uncertainty of the severity of injury of the patient. In order to manage these difficulties the radiographers in this research used communication skills to assess the patient and reduce the ambiguity and uncertainty related to the injury. When the examination is routine little cognitive input is required however more intermediate and complex examinations require the generation of potential solutions (Newel & Simon,1972). This step in the problem-solving process draws on many factors including declarative knowledge and procedural knowledge (Hardin, 2002) drawn from experience. Some of this process is subconscious and some novel situations require more cognitive input with analytical skills employed.

This discussion will consider the research findings and is structured chronologically starting with the assessment of complexity followed by conduct of the examination since this is how the activities would be undertaken in practice (with some degree of synchronicity). The discussion of the assessment process also considers the role of the imaging request card in the process and the concepts of problem-solving and experience will be considered in the discussion of the conduct of the examination and will be mapped against the theoretical framework that underpins this research. The remainder of the chapter will also consider the potential limitations of the research and will conclude with recommendations for future study.

4.7. Consideration of the assessment process

Before positioning the patient the radiographer assesses the patient using the request card and communication with the patient. A three stage assessment process was identified. Elements of the three stage process identified in this research have been identified in other areas of practice (Silverman, Kurtz, Draper, 2005) and within radiography (Nightingale et al., 2015). The assessment process can be mapped to the first stage of the Newel and Simon model of problem-solving (1972) which is defining the problem. The literature tells us that the skills of problem framing (Rothman, 1997) are supported during training using Problem Based Learning, clinical experience (Schaefer & Zygmont, 2003) and assessment (Baird & Wells, 2001).

The first stage of the process is to define what is known, which is achieved by review of the request card and visual assessment of the patient. Deciding what is not known is conducted simultaneously and the radiographer uses questioning to address any gaps in their knowledge (Rothman, 1997). Figure 15a maps the assessment process against the first stage of the Newel and Simon (1972) model and the theoretical framework employed.

Figure 15a. Mapping of the assessment process against the first stage of Newel and Simon problem-solving model (1972)

Define the problem		
Decide what is known	Decide what is not known	Gather information to address what is not known
Review of request card Review of previous images and notes Observation of patient		Questioning Observation Image review

Alongside the request card radiographers have access to patient records and can review previous images to help inform the examination. The use of "pre-encounter data" in the form of the request card, notes and previous images is similar to that described in nursing by Taylor (1997) when the nurse reviews the patient notes. In practice referral to the patient records and previous images was observed as helping the radiographer plan the examination.

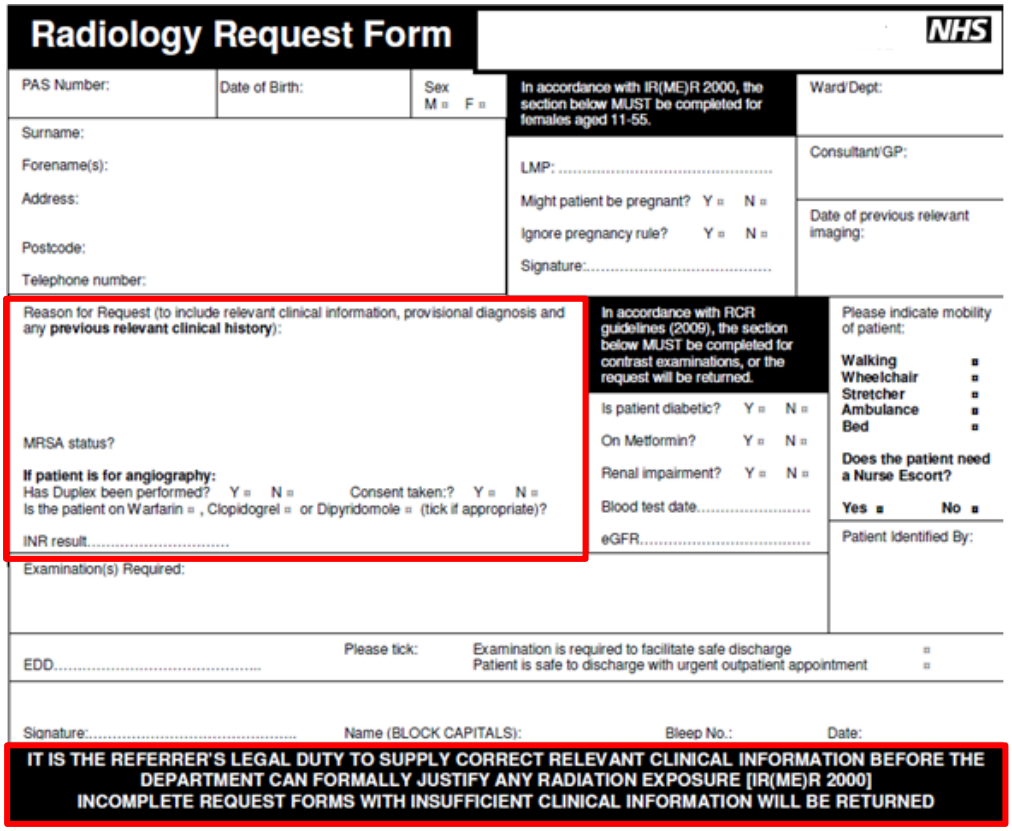
Nurses benefit from additional sources of information which are verbal reports of the patient during hand over on the ward and they may also have an existing relationship with the patient if they are an inpatient. Similarly radiographers were observed consulting colleagues to help plan examinations. Like radiographers, nurses also assess patients they have not encountered previously e.g. triage nurses. In triage nurses gather additional information from the patient using physiological assessment (blood pressure, heart rate etc. Gertz & Bucknall, 2001). They also gather information about the patients' discomfort using self-reporting pain scales. These scales are used to indicate the intensity of pain that the patient is experiencing. Self-reporting of pain is considered to be the most accurate pain assessment method (Campbell, 2006) and is frequently recorded using a numerical or face scale (Pautex & Gold, 2006). Radiographers use their communication skills to assess the level of pain experienced by the patient but it is not clear why they do not use the pain scales employed by other professions. Observation of radiographers in practice saw them gathering information to frame the problem, and also saw them make inferences from the request card.

4.7.1. The request card

The request card is an artefact (Hammersley & Atkinson, 2007) of the profession of radiography. The radiographers use the request card as the first step in the assessment of the patient, the information review phase (Newton-Hughes & Robinson, 2013). The radiographers reviewed the patient age, presentation, clinical history and request to inform their assessment. Problem-solving literature (Kahneman, 2011) suggests that information and specific words can prime action and it may be possible that the information provided on the request card primes that behaviour of the radiographer, predisposing them to conduct the examination in a particular manner. The request card could be considered to be comparable with the "pre encounter" data reviewed by nurses (patient notes) to help inform their problem-solving processes (Taylor, 1997). Radiographers in this research often commented upon the lack of detailed clinical history provided by the request card. This is a frequent complaint. In 2012 Afolabi, Fadare and Essien found that only 34.4% of request cards contained sufficient clinical information. In their UK based study in 2009 Oswal, Safferson and Rehman noted that there is a problem with incomplete request cards worldwide and recommended that training, improvements in availability of support material and changes to the request card be made. If we review the request card used within the trust where the research was conducted (figure 10a) we can see that the largest field on the request card is for

input of clinical information and there is clear guidance on what should be included (clinical information, provisional diagnosis and any previous relevant clinical history). It can also be seen that there is a note to the referrer at the bottom of the form which suggests that requests with insufficient clinical history will be returned. Despite radiographers frequently discussing the lack of information on the request card there were no instances of return of the request card observed during the research.

Figure 10b. Example of the request card used at the research sites



Radiology Request Form NHS

PAS Number: | Date of Birth: | Sex M ▫ F ▫

Surname:
Forename(s):
Address:
Postcode:
Telephone number:

In accordance with IR(ME)R 2000, the section below MUST be completed for females aged 11-55.

LMP: .....
Might patient be pregnant? Y ▫ N ▫
Ignore pregnancy rule? Y ▫ N ▫
Signature:.....

Ward/Dept:
Consultant/GP:
Date of previous relevant imaging:

Reason for Request (to include relevant clinical information, provisional diagnosis and any **previous relevant clinical history**):

MRSA status?

If patient is for angiography:
Has Duplex been performed? Y ▫ N ▫ Consent taken:? Y ▫ N ▫
Is the patient on Warfarin ▫ , Clopidogrel ▫ or Dipyridomole ▫ (tick if appropriate)?

INR result.....

In accordance with RCR guidelines (2009), the section below MUST be completed for contrast examinations, or the request will be returned.

Is patient diabetic? Y ▫ N ▫
On Metformin? Y ▫ N ▫
Renal impairment? Y ▫ N ▫
Blood test date.....
eGFR.....

Please indicate mobility of patient:
Walking ▫
Wheelchair ▫
Stretcher ▫
Ambulance ▫
Bed ▫

Does the patient need a Nurse Escort?
Yes ▫ **No** ▫

Patient Identified By:

Examination(s) Required:

EDD.....

Please tick:
Examination is required to facilitate safe discharge ▫
Patient is safe to discharge with urgent outpatient appointment ▫

Signature:..... Name (BLOCK CAPITALS): Bleep No.: Date:

IT IS THE REFERRER'S LEGAL DUTY TO SUPPLY CORRECT RELEVANT CLINICAL INFORMATION BEFORE THE DEPARTMENT CAN FORMALLY JUSTIFY ANY RADIATION EXPOSURE [IR(ME)R 2000]
INCOMPLETE REQUEST FORMS WITH INSUFFICIENT CLINICAL INFORMATION WILL BE RETURNED

What can also be seen is that despite the large box provided, much of the space for response has been used for explanation of what should be included in the box and questions about MRSA and angiography. This reduces the space available for clinical history to approximately a third of the original size. Christian and Dillman (2004) and Israel (2006) tell us that increasing the size of a response box in research increases the quantity and quality of information provided and it could be surmised that this reduction in space may influence those completing the request card suggesting that minimal information is required. This lack of information means that the radiographers use their communication skills during the assessment at introduction to question the patient and gain more information relevant to the examination. It is at this point that the good communication skills described by Terry and

Higgs (1993) are applied. It can be surmised then that a lack of information on the request card encourages the radiographer to question the patient, a practice which was met with mixed responses in the work of Prime and Le Masurier (2000), and could be seen to be helping to foster the relationship between the patient and the radiographer and influence the radiographers imaging choices (Lam, Egan, Baird, 2004). It is worth noting that radiographer 4 discussed the additional postgraduate training in patient interview skills they had received and they considered that this along with their additional training in trauma assessment had improved their skills and influenced their ability to position the patient. They felt that the additional training in trauma assessment allowed them the confidence to move the patient more than they might previously have attempted.

"so I have done a physiotherapy of limbs and I have done interview techniques of erm trauma patients with musculo-skeletal injuries so I will ask certain questions and it will influence, it will guide me on my examinations what I can manipulate the im.. the examination to improve it" Radiographer 4

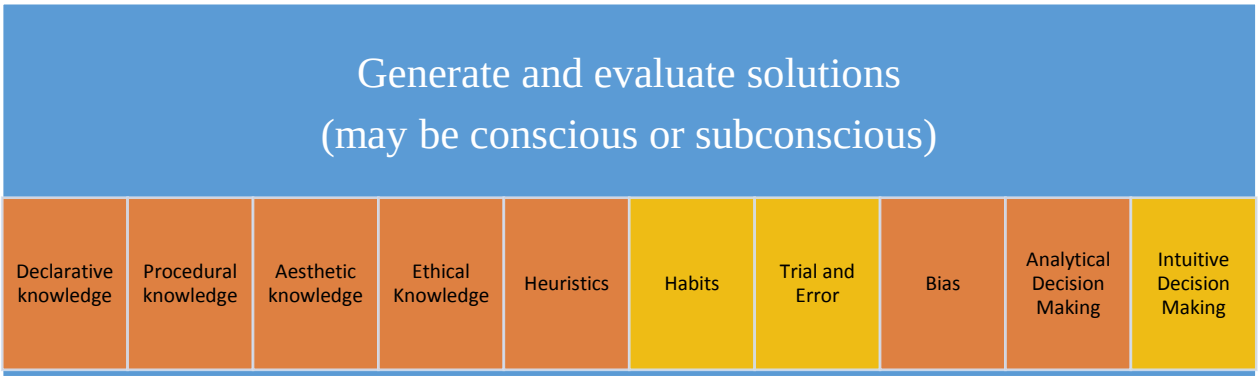
These anecdotal comments support the suggestions of Lam, Egan and Bird (2004). Their work proposed that radiographers should be taught patient interview skills as their study found that interviewing the patient influenced the problem solving and decision making of the radiographers. An additional benefit of increased communication with the patient might also present the profession with the opportunity to move from the medical reductionist model of practice where the "medical gaze" (Foulcault, 1975) is used to reduce the patient to the condition that is affecting them rather than treating them as a whole. While reviewing a blank request card and having discussed the use of pain scales earlier it would seem sensible to include a numerical pain scale in the clinical information box to allow the requesting clinician to indicate the patients' level of pain in the trauma setting. The use of a pain scale would also allow the voice of the patient to be heard in relation to the level of pain they are experiencing. Callister (2003) tells us in her review of culture and pain perceptions that levels of pain from similar stimuli are reported as having different intensities by members of different cultures. Asking the patient for the level of pain they perceive would mitigate the interpretation of the radiographer, who may be from another culture, in assessing the patient. This would allow the radiographer an additional source of information to support their problem solving and would also provide an indication of the context of the examination for those reporting the images. Those reporting the images have little insight into the complexity

of the imaging examination their role being to report the images from an examination they have not conducted. While this might be considered a sensible inclusion on the form it may also be un-necessary addition to a form which is not always fully completed (Afolabi, Fadare, Essien, 2012).

The assessment process allows the radiographer to frame the problem and define the complexity of the examination. The classification tool developed to assist the data analysis for this research mapped well with the radiographers' assessment of the patients with only four instances of discordance between the complexity tool and the opinion of the radiographer. Two of these demonstrated an increase in complexity as the examination progressed and two were less complex than originally estimated. Therefore further work needs to be undertaken to validate this classification tool.

Having framed the problem the radiographer moves to the second stage of the problem-solving process, generating and evaluating solutions. The literature review identified the complexities of this process as demonstrated in the theoretical framework. Figure 15b illustrates this.

Figure 15 b. Mapping of the problem-solving processes against the second element of theoretical the framework

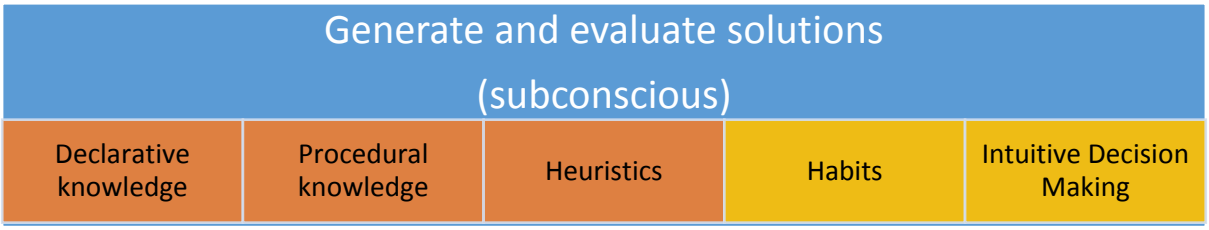


Different elements of this stage were employed with different examinations. There was a difference in practice between the routine and intermediate and complex cases. In order to explain the findings the discussion will relate the elements of solution generation to the complexity of the examination. To illustrate this the findings were related to the theoretical framework developed.

4.8. Routine examinations

In 1986 Dreyfus and Dreyfus said *"When things are proceeding normally experts don't solve problems and don't make decisions: they do what normally works".* This was certainly the case in the routine examinations observed. The radiographers undertaking routine examinations could not articulate what processes they undertook during this type of examination indicating that the process is subconscious. Underpinning this process was declarative and procedural knowledge, there was no need to draw upon aesthetic and ethical knowledge since the situation presented no additional complexities which required ethical or contextual considerations. Rules of thumb (heuristics-cognitive) and habits (behaviourist) were relied upon to inform the conduct of the examination and the examinations were conducted intuitively. The behaviours observed are typical of those explained by Embrey's cognitive continuum (1997) and "skill based behavior". Figure 15c illustrates this.

Figure 15 c. Mapping of the problem-solving processes for routine examinations against the second element of the theoretical framework



Declarative knowledge is underpinning factual information and can be provided by educational institutions. Procedural knowledge is "know how" and is related to skills development (Anderson, 1981). Procedural knowledge comes from experience (Nickols, 2000). Experience was frequently mentioned by the radiographers in the research and is implicit in the earlier quotation from Dreyfus and Dreyfus (1986). What is not understood is how much experience is required to become expert at a task so that it can be considered routine and intuitive. The nursing literature reviewed earlier suggested that general experience was not related to problem-solving efficacy (Göransson, Ehrenberg, Marklund, Ehnfors, 2006) but efficacy correlated to experience in the specific area of practice. Student radiographers reported that having just limited experience in practice allowed them to complete theoretical problem-solving assessments with ease (Baird & Wells**,** 2001) but this did not explain whether the problem solving they applied was intuitive or analytical. In her

model Baylor (2001) discusses how intuition develops with expertise; her U shaped model can be considered to contain two elements of intuition in a three phase model. The initial phase is immature intuition, the middle phase is analytical the later phase being mature intuition. Baylor argues that the difference between immature and mature intuition is reliant upon the development of expertise. She suggests that novices employ a high level of intuition which reduces as they gain more understanding of the area (procedural knowledge) and the analytical structures associated with it. With experience the use of intuitive problem solving begins to rise until the clinician is an expert. Baylor uses examples from child development to support this argument. Baylor's model of intuition builds upon the work of Dreyfus and Dreyfus (1980) who suggest that decision making develops with experience, with novices using a more analytical approach.

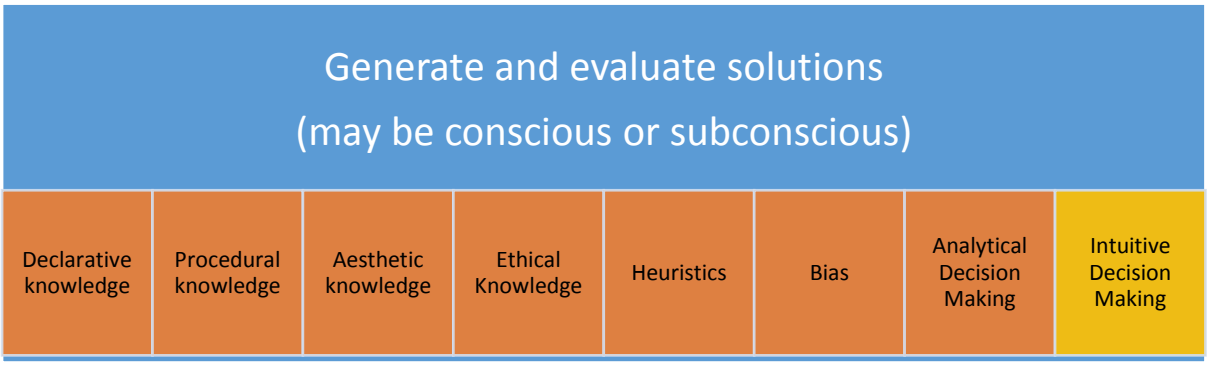
Almost fifty percent (31/63) of the cases observed in this research were classified as routine suggesting that involvement in clinical practice could provide experience of a large number of routine cases in a short period of time making the move from novice to expert quite quick in this sphere of practice. This suggestion is supported by the development of assistant practitioner programmes which develop competency in routine examinations of the chest, axial and appendicular systems within a part time eighteen month training package (University of Hertfordshire, 2014) and the comments from the student undertaking SOLAR examinations "The cases were useful-especially if one had covered the topic while on clinical visits……If you had already done it the case was easier and if you hadn't there was a lot to learn…" (Baird & Wells, 2001). The radiographers in this study had a range of 1.5- 32 years' experience post qualifying when the study was undertaken and it could be considered that by this time they would have encountered many routine appendicular examinations and will have become experts in routine examinations allowing them to use mature intuition in these situations.

4.9. Intermediate examinations

This classification of examinations included younger patients. Imaging examinations of children can be more complex to undertake as their level of understanding and co-operation is not often evident until the examination has commenced (Hardy, 2000). These examinations can change rapidly if the child becomes distressed and requires a change in communication style to gain the co-operation of the patient (Harding & Davis, 2015). Intermediate examinations often employed rules based problem solving (Embrey, 1997) with staff

describing the use of similarity heuristics and recognition primed behaviour. In one instance a radiographer described using a similarity heuristic when a routine examination proved to be more complex than anticipated. Their initial approach had been intuitive and skills based. They identified that the situation required more thought and employed recognition primed behaviour to solve the problem. This behaviour demonstrated the second element of recognition primed decision making "if this is like this then". Radiographers imaging intermediate cases more frequently reviewed the first image produced to add additional information allowing for an adjustment to the solution which accommodated the additional difficulty identified. These findings can be used to support the notion of training students to gather more information during the examination to support their problem solving and decision making. Figure 15d demonstrates this.

Figure 15 d. Mapping of the problem-solving processes for intermediate examinations against the second element of the theoretical framework

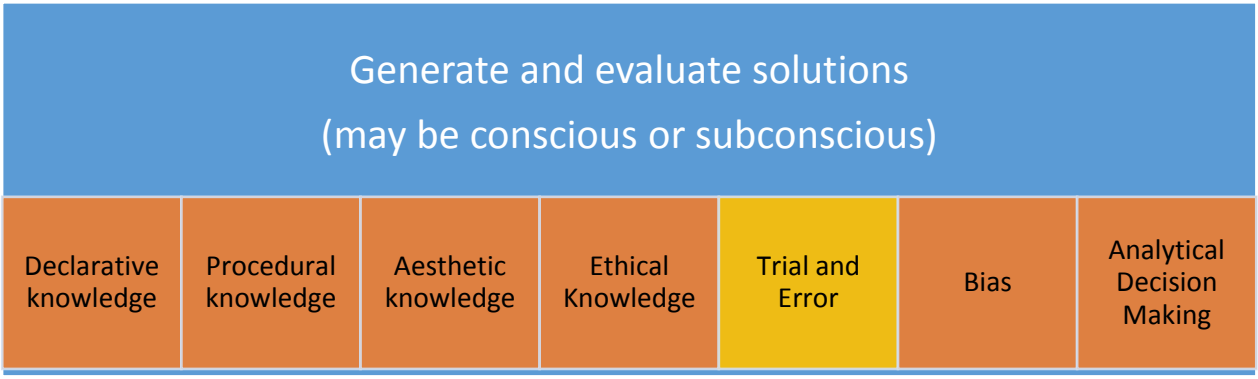


4.10. Complex examinations

Complex examinations were the least frequently observed in practice. These examinations were novel (Hardin, 2002) and the radiographers did not have a solution to the problem readily available to recall and a set of behaviours readily developed which they could follow (rules based problem solving-Embrey, 1997). In these situations all types of knowledge were drawn upon, the context of the examination was important. The potential to do harm to the patient by exacerbating an injury was assessed to be more likely and thus ethical knowledge was also applied. These examinations required cognitive input and analysis used analytical problem solving. In some instances trial and error was applied, one radiographer described this as "playing it by ear", trying out potential solutions until a satisfactory solution was found. The solutions typically mean that the radiographers did not change the position of the

body part and imaging was achieved by moving the equipment around the patient and lifting the body part only to place an image receptor adjacent to the area of injury. As educators we could apply this to inform our teaching both in terms of clinical skills and approach to complex examinations but also to raise awareness of the problem-solving process and the variety of approaches which can be applied. Figure 15e illustrates this.

Figure 15 e. Mapping of the problem-solving processes for complex examinations against the second element of the theoretical framework



4.11 Theoretical framework

As a result of the literature review a theoretical framework was employed to demonstrate the theoretical concepts of problem-solving in general real world situations, using Newel and Simons' problem-solving model to describe the steps and other theories to illustrate what happens within each step (1972). As demonstrated above this framework was successfully applied to the findings of the study and could be readily mapped to the observed examinations irrespective of the examination complexity.

4.12. Other factors for consideration

Communication was a key feature of the papers examined as part of the literature review with frequent discussion of the importance of communication in assessing the patient and in developing a professional relationship with the patient. The radiographers observed for this research used communication to gather further information about the patients during the assessment at introduction and throughout the examination. When examining patients with more complex needs they used communication to ensure the comfort of the patient. Although

less frequently acknowledged the radiographers also used communication to build rapport with the patient commenting on the injury to display empathy with the patient.

"*…also I think it's just a quite nice just to actually just communicate with the patient so, you know, you are going to have to be quite mean to them especially when you are doing A and E work so it's quite nice just to get a bit of chat going…*" Radiographer 12 patient1

Andersson, Fridlund, Elgan, and Axelsson (2008) suggest that the radiographers use communication to empower the patient, this was less evident in this research however, in their study the sample included other forms of imaging examination including MRI and CT where the nature of the examination increases the length of patient contact time and provides the opportunity for further communication. As noted by the participants in Prime and Le Masuriers' (2000) study radiographers working in a trauma environment do not have the time to converse with the patient at length and opportunities for extended communication are limited. Some participants also expressed concern at the level of questioning employed by the radiographer suggesting it was not the radiographers' role. While this is the case in that study in their study Lam, Egan and Baird (2004) recommend increased communication between the radiographer and patient to support radiographer decision making and improve patient care and service. With the move to from traditional hierarchical approaches in healthcare to patient-centred care (Hibbard, 2004) improved communication between health professionals and staff should be encouraged.

The observational data suggested that the majority of examinations were commenced with the Antero-Posterior projection. The radiographers could provide no clear rationale for this other than the observation that they had been taught the projections in that order. It is also interesting to note that in the study by Prime and Le Masurier (2000) which used think aloud observations of video scenarios the radiographers commented on the unusual technique when a radiographer in the video commenced with a lateral projection. It is unclear why this is the case unless it is that this is the way the patient presents in the erect, seated and supine position. It is clear that patients who are ambulant and unsupported by slings, or with fixed extended limbs, usually present in the Antero-Posterior position and that in these cases it is more practicable to image the patient in this position rather than moving them from this comfortable neutral position to another to initiate imaging, however patients who present with flexed limbs might be approached with a similar rationale and imaged in the presenting

position (lateral). Raising awareness of these issues with radiography students should make them more aware of these subconscious actions and help inform their problem solving.

The observational and interview data identified one radiographer who was reluctant to move the patient to position them irrespective of the outcome of their assessment of complexity. The interviews with this radiographer suggested that past experience had made them to reluctant to move the patient. This type of behaviour is similar to the avoidance approach to problem solving described by Morera et al. (2006) when discussing personality type in problem solving. As the name suggests an avoidance style means that problems are ignored in the hope that they will resolve, or attempts to shift the responsibility for the problem to somebody else. While this research did not gather data on personality type it was evident on discussion at interview with this radiographer that she conformed to Morera's (2006) description of avoidance style and the gathering of this data might be used in further studies and could be considered when screening applicants to undergraduate radiography programmes when the need to select future practitioners who can problem solve is paramount.

4.13. Critique of the methodology

Ethnography combines observation and interview to examine behaviour within a culture (Geertz, 1973). Investigating the routine behaviour of radiographers in this focused ethnography required observation and questioning of their practice in the clinical setting and in this specific context observation of appendicular trauma imaging.

Observation presented two difficulties: the researcher role and study numbers.

4.13.1. The researcher role

When discussing access to the participants with the site managers it was agreed that I would not wear clinical uniform so that staff were clear that I was acting as a researcher and not a radiographer. Despite this visual indication it was difficult for staff to differentiate my role as a research from my qualification as a radiographer. On occasion I was left in the room to observe a patient while the radiographer reviewed their CR images. I was uncomfortable with this as I had not received training in emergency procedures within the trust and would be uncertain how to act should the patient collapse. To avoid this situation I routinely followed the radiographer out of the room whenever they left. This presented another difficulty as the

radiographer usually left the room to review their images. The purpose of the research was to uncover the problem-solving process; it was not intended to assess the quality of the problem solving. One way of estimating the success of the problem solving would be to review the images produced. I did not want the radiographers to feel that I was judging the quality of their images and despite following the radiographer from the room I tried not to review the images with them unless they actively encouraged me to do so. A further difficulty of the researcher/radiographer role arose when observing the practice of radiographers. I did not observe any unsafe or unprofessional practice but I did observe a radiographer make an error which may have required a repeat examination. The radiographer left an image receptor they had just exposed in the room when going to expose for a second projection. This second exposure may have resulted in re-exposure of the first image receptor and been detrimental to the image requiring re-imaging of the patient. To avoid the need for re-exposure of the patient I intervened and pointed out the error to the radiographer who retrieved the image receptor before making the exposure. I was uncomfortable making this intervention but my professional role in relation to patient safety overruled my discomfort. While not having a direct impact on the outcome of the study this intervention might have influenced my relationship with the radiographer and made them reluctant to allow me to watch further examinations. Had my intervention been discussed with colleagues this might also make them reluctant to allow observation of their behaviour and may have reduced the potential number of study observations.

4.13.2. Study numbers

A very specific area of practice was selected for this research. The only previous study of problem solving/decision making in radiography undertaken in practice evaluated the image review process (Bowman, 1997). As the radiographers role is to produce images there were many opportunities to observe this process. The scope of investigation for this research was comparatively very narrow with a specific examination type being observed. In the accident and emergency setting the most frequently requested examination is a chest x-ray. Appendicular imaging is less frequent and as a result gaining a sufficient data sample required extended attendance in the imaging department. Attendance times and days were varied in order to maximise opportunities for data collection but opportunities were limited since this was not a full time study. Notwithstanding this over 60 observations were conducted.

Other factors also influenced the number of observations undertaken. The research required ethical approval and as part of that approval it was necessary to consider the issue of unsafe practice. The letter of introduction to the research explained that as a radiographer I would be obliged to report any unprofessional behaviour observed to the department managers. It is likely that this influenced the staff making them less likely to volunteer for the research. In total 20 staff from site A and B agreed to participate in the research however only 15 staff were observed in practice. This may be because they were not on duty when the observations were undertaken, they did not receive an appropriate request while I was present or despite having agreed to participate in the research they were actually reluctant to be observed. This may in part be related to the post observation interview which presented its own difficulties. It could be argued that increasing participant numbers might increase the generalisability of the study however Yin (2014) and Myers (2000) argue that smaller sample sizes allow detailed study and provide findings useful to the wider community.

As a result of the infrequency of extremity examination requests there were periods of time when observations were not possible. These frequent periods of inactivity while being unproductive in terms of observations meant that observer fatigue did not affect the quality of the data gathered.

4.13.3. Post observation interviews

As a percentage of the number of examinations conducted, most of the observations were of routine examinations. As the data has revealed many of these examinations are conducted subconsciously and as a result of this radiographers were not aware of their assessment of the patient or their problem solving. Asking radiographers who are unaware of their actions why they were performing them proved complex. They frequently recognised that they were not aware of their actions but could not provide an insight into why or how they had solved the problem. Often they reported that they had not solved any problems or made any decisions during the examination. Benner (1984) also noted that experts are often unable to explain their practice as it is subconscious. It was not possible to ask the same radiographer some of the questions repeatedly after each observation e.g. “why do you do the AP first”. If the radiographer could not articulate their rationale for the first examinations observed it was un-necessarily repetitive to ask the question in subsequent observations. Interview questions were also left out following later observations, having asked the same radiographer the same question several times the question was omitted from subsequent interviews, this avoided

respondent fatigue which occurs when the respondent becomes bored with the process and as such the quality of the data gathered deteriorates (Ben-Nunn, 2008). This meant that some data was not recorded for every observation and interview and the data tables used to demonstrate the changes in conduct of the examination appear incomplete.

4.13.4. Limitations of the data analysis

As noted when considering the interview data the same data was not gathered for every observation. This has resulted in an incomplete data set which can best be demonstrated when reviewing the data tables produced using the complexity analysis (appendix 2a page 158). This was in part due to the iterative nature of the data analysis (Hertz 1997) and the individual practice of radiographers. As the observations were undertaken the actions of the radiographers which required further investigation were indicated on the field notes and used to inform the post observation interview. The radiographer observations were not conducted sequentially, participant fifteen might be observed repeatedly before participant eleven was observed. When participant eleven was observed a further question might be prompted which was included in all subsequent interviews, but this question would not have been asked previously. This might also mean that subsequent observations included actions which had not been recorded previously. This resulted in gaps in the previously gathered data where the action had not been noted or the question not posed at interview. This research is however qualitative in nature and does not rely on complete numerical sets of data to support the findings. The research did use this type of data to support the findings of how and when the radiographers modify their practice with the complexity of the patient and a more complete data set might have been beneficial for this purpose.

4.13.5. Leaving the field

One final difficulty was encountered and this is considered to be “leaving the field”. Bloor and Wood (2006) tell us that this is an important part of conducting the research. They also remind us that one of the key ethical principles of research is to do no harm. Having spent several weeks alongside the research participants, having gained entry into their community of practice (Lave &Wenger, 1991), shared their stories and jokes, and observed their practice I was an accepted member of their team and I needed to leave the team without any detriment to the ongoing professional relationship I would have with the radiographers. Leaving the

field was also difficult on a personal level. I had spent many years in clinical practice as a radiographer and the research had allowed me to re-join the "grass roots" of my profession. I enjoyed working alongside the staff and patients and was reluctant to return to my routine role. Having gathered sufficient data and with the requirements of a full time occupation to fulfil I needed to leave the field. With some encouragement from my supervisor (Bloor & Wood, 2006) I returned to the department for a final time in my role as a researcher and thanked the participants, the other staff I had worked alongside and the departmental managers.

4.14. Summary of the findings

This unique research has demonstrated that radiographer problem solving can be successfully mapped to the first two stages of the Newel and Simon general problem-solving model (1972) and the theoretical framework employed. Much of radiographer problem solving is intuitive drawing on skills based practice derived from experience when the examinations are straightforward. In these examinations patients are imaged automatically with little cognitive input required by the radiographer. This requires less working memory capacity (Kahneman, 2011). The ability of the radiographer to do this allows them to focus on other aspects of the examination. As the examinations increase in complexity the radiographers' problem solving can be mapped to Embrey's cognitive continuum (2007). Radiographers move to rules based cognitive skills to solve problems based on past experience using heuristics to help conduct examinations of intermediate complexity. When the situation is complex radiographers have been observed to use their knowledge base and trial and error to solve these novel and ill-defined problems. As the cognitive skills employed in problem solving change with complexity so do the actions of the radiographers. The behaviour of the radiographer reflects their assessment of the patient injury, their desire not to exacerbate the injury makes them reluctant to move the body part as the complexity of the examination increases. Routine cases are conducted with the radiographer prepared to move the patient body part having demonstrated the position. Intermediate cases often required the radiographer to move the patient rather than asking the patient to follow an explanation or demonstration. For complex cases the radiographers chose not to move the patient to position them. These patterns of behaviour are exhibited by the majority of radiographers observed. They are not taught but are implicit features of the radiographers practice. By making them explicit this new

understanding of the actions and cognitive process undertaken by the radiographers can be used to support those entering the profession.

4.15. Application of the research findings

The findings of the research have provided an insight into the problem solving used by radiographers in the trauma setting. It is clear that there is still much to learn about how radiographers solve problems in practice. This research has added to the understanding of radiographer problem solving and the presentation of the research findings will raise awareness of this complex topic within the radiography profession. Alongside the findings in relation to problem solving several other matters have been considered. A three stage assessment process has been observed. Further study should be conducted to evaluate and confirm the use of this process in the practice setting. This process could then be used to support the education of students and provide a structured process for radiographers to follow until experience allows the process to become intuitive.

A review of a blank request card has highlighted some limitations in term of the design of the form in use at the research sites. Changes to the form could be made to encourage the inclusion of a more detailed clinical history to support the radiographer's assessment of the patient with an increase in the size of the field to be completed and removal of erroneous questions from the field. Radiographers assess the patient to evaluate extent of injury but do not use pain scales to inform this process. Many health care professions use pain scales to assess patient injury and mobility. Self-reported pain scales are considered to be the gold standard in assessing patient pain (Campbell, 2006). It is not clear why this information is not provided to the radiographer on the request card or why the radiographer does not use this tool as part of their assessment process. It should be possible for the referrer triaging the patient to include this information with the clinical history for the patient or for radiographers to receive additional training in the use of pain scales to inform their assessment of the patient. It is also clear that radiographers question the patient in order to assess their level of injury and ability to comply with the positioning for the examination. No formal interview teaching is provided at undergraduate level in the training programmes I am associated with. Both research (Lam, Egan & and Baird, 2004) and anecdotal radiographer comments (radiographer 4) suggest that additional interview skills might be beneficial. It can be seen that improving communication skills with the patient will inform the radiographers' problem-solving process and increase the patients' participation in the examination moving towards

patient centred care (Hibbard, 2004) and broadening the "clinical gaze" (Foulcault, 1975) of the radiographer. It is unclear why these skills are developed at post graduate level and not explicitly at undergraduate level and it is recommended that this should be included in the undergraduate curriculum.

In order to understand the data a method of estimating the complexity of the examination was developed. This tool should be evaluated and validated as it could prove useful in both the educational and clinical setting. In the educational setting the tool could be used to provide a structured measure of complexity which the students could apply to help them develop appropriate problem-solving skills for application in practice. The tool could also be used to guide clinical staff about which examinations are appropriate for students to undertake in practice and how much support a student may require when undertaking an examination. At present students are encouraged to conduct examinations of increasing complexity as they progress from year to year in their programme of study. When encountering patients with increasingly complex needs it must be difficult for the radiographer to know what level of complexity the student is capable of managing and what is an appropriate level of examination complexity for that student to undertake. Students' clinical skills' are also assessed when they conduct increasingly complex examinations in the academic setting. At present there is no recognised tool for measuring the complexity of the examination and the decision is based on the perspective of the radiographer in practice or the academic setting the examination. Using a recognised tool would add rigor to this process. As mentioned previously the clinician reporting the images reviews them without an understanding of the complexity of the examination. Radiographers can annotate electronic patient notes to add comments about the examination but there is no standardised system for doing so. By applying the complexity rating to the patient records the clinician reporting the image could be provided with information relating to the context of the examination. In their study Lam, Egan and Baird (2004) concluded that the provision of additional information supported those interpreting the image and it seems that it may be beneficial if a complexity assessment was added to the information being reviewed by the reporting clinician.

A theoretical framework has been employed which has applied the work of Newel and Simons' (1972) and other authors to the practice of radiographers. Application of the other theories utilised in the framework has allowed understanding of radiographer behaviour and cognitive activities in the first steps of problem-solving. The framework has proved adaptable

allowing accommodation of changes in approach for routine, intermediate and complex examinations and could be utilised for understanding radiographer behaviour in other areas of practice.

4.16. Research recommendations

The following are recommendations for further study based on the outcomes of this research:

Further focused ethnographic studies should be conducted within this area of practice to examine these early findings. These studies might consider gathering additional participant data in relation to personality types in problem solving before conducting the research.

Further work to validate the complexity classification tool.

Further focused ethnographic studies should be conducted in other areas of radiographer practice to develop more general understanding of radiographer problem solving.

4.17. Conclusion

In line with the aim of the research an understanding of how radiographers position a patient for appendicular trauma imaging has been achieved.

The research objectives have been addressed:

1. To observe the problem-solving processes a Diagnostic Radiographer undertakes when examining a patient with traumatic appendicular injury.
2. To describe the clinical practise of radiographers in this scenario.
3. To explore problem-solving literature to develop an understanding of the models of the problem-solving that may be applied in this clinical scenario.
4. To identify any of the research findings which might be applied in education and practice.

Sixty three observations were made of clinical examinations which allowed exploration of the problem-solving processes employed when positioning patients for appendicular radiographs in the trauma setting.

It has been possible to describe the actions of the radiographers when conducting these examinations and identify the models of problem-solving applied using the theoretical framework identified and developing this further by consideration of complexity. Radiographers employ a three stage assessment process to estimate the severity of the patients' injuries and then adapt their behaviour in conducting the examination based upon their assessment. Much of the assessment process is subconscious and little conscious thought is required to conduct examinations deemed routine by the assessment process.

The problem-solving processes applied to this element of practice in the trauma setting have been observed and explored and mapped to current theory in relation to general problem solving and decision making. The influence of complexity has been compared to the described models of level of cognition required in problem solving and similarities noted.

Outcomes have been identified which might be employed in research, clinical and educational practice following validation of these findings.

This research is unique in the field of radiography and as such there is little information available to validate the findings of the research. Qualitative research is interpretive in nature and it is therefore imperative that these findings are validated by further study in this field before the findings can be applied in practice and education. Further work in the field of problem-solving is also required to inform the problem-solving processes undertaken by radiographers working in the many areas of imaging practice as their level of autonomy and responsibility increases. The development of the theoretical framework may assist with this. This research has reviewed one small area of practice and only one facet of the problem - solving required to complete an entire imaging examination in the trauma setting. As can be appreciated radiographers conduct many types of imaging examinations, trauma radiography being only a small component of their role.

References

Adler, P. A., & Adler, P. (1998). 'Observational techniques'. In N. Denzin and Y. Lincoln (Eds.), *Collecting and Interpreting Qualitative Materials*, London: Sage.

Ahonen, S. M. (2009). Radiographer's work in Finland–A conceptual review. *European Journal of Radiography*, *1*(2), 61-65.

Afolabi, O. A., Fadare, J. O., Essien, E. M. (2012). Audit of completion of Radiology Request form in a Nigerian Specialist Hospital. *Annals of Ibadan Postgraduate Medicine, 10*(2), 48-52.

Alfaro-LeFevre, R. (2009). *Applying Nursing Process: A Tool for Critical Thinking*. Philadelphia. PA: Lippincott Williams and Wilkins.

Anderson, J. R. (1981). *Cognitive Skills and Their Acquisition*. Hillsdale, NJ: Lawrence Erlbaum.

Andersson. B. T., Fridlund, B., Elgan, C., Axelsson, A. B. (2008). Radiographers' areas of professional competence related to good nursing care. *Scandinavian Journal of Caring Science, 22*, 401-409.

Andersson, A., Omberg, M., Svedlund, M. (2006). Triage in the emergency department – a qualitative study of the factors which nurses consider when making decisions. *British Association of Critical Care Nurses, Nursing in Critical Care*, *11*(3), 136 – 145.

Bailey, J. (2008). First steps in qualitative data analysis: transcribing. *Family practice*, *25*(2), 127-131. doi: 10.1093/fampra/cmn003

Baird, M., & Wells, P. (2001). SOLAR: student oriented learning about radiography. *Medical Teacher, 23*(4), 407-411.

Bakkalbasi, N., Bauer, K., Glover, J., & Wang, L. (2006). Three options for citation tracking: Google Scholar, Scopus and Web of Science. *Biomedical digital libraries*, *3*(1), 7.

Banning, M. (2008). A review of clinical decision making: models and current research. Journal of clinical nursing, 17(2), *187-195.*

Barnard, C. I. (1938). *The Functions of the Executive*. Cambridge: Harvard University Press.

Baylor, A. (2001). A U-shaped model for the development of intuition by level of expertise. *New Ideas in Psychology, 19*(3), 237–244.

Ben-Nun, P. (2008). Respondent fatigue. In P. Lavrakas (Ed.), *Encyclopedia of survey research methods.* (pp. 743-744). Thousand Oaks, CA: SAGE Publications. doi: 10.4135/9781412963947.n480

Benner, P. (1984). *From novice to expert*: *excellence and power in clinical nursing practice.* Menlo Park CA: Addison-Wesley.

Berg, S. (2006). Snowball Sampling. In S. Kotz, C. B. Read, N. Balakrishnan, & B. Vidakovic (Eds.), *Encyclopaedia of Statistical Sciences*, (pp. 7817-7821). Hoboken, NJ: John Wiley and Sons, Inc.

Bernard, H. R. (2006). *Research Methods in Anthropology: Qualitative and Quantitative Approaches* (4th ed.). Oxford: Rowman & Littlefield publishers, inc.

Betsch, T. (2008). The nature of intuition and its neglect in research on judgment and decision making. In H. Plessner, C. Betsch, & T. Betsch (Eds.), *Intuition in judgment and decision making* (pp 3-22). Mahwah, NJ: Lawrence Erlbaum.

Bisanz, J., & LeFevre, J. (1990). Strategic and nonstrategic processing in the development of mathematical cognition. In D. F. Bjorklund (Ed.), *Children's strategies: Contemporary views of cognitive development* (pp. 213-244). Hillsdale, NJ: Erlbaum.

Blackler, F. (1995). Knowledge, knowledge work and organizations: An overview and interpretation. *Organization studies*, *16*(6), 1021-1046.

Bloor, M., & Wood,F. (2006). Leaving the Field. In *Keywords in Qualitative Methods. (pp.112-113).* London, england:SAGE Publications Ltd.

Booth, L. A., & Manning, D. J. (2006). Observations of radiographer communication: An exploratory study using Transactional Analysis. *Radiography*, *12*(4), 276-282.

Bowman, S. (1995). Decisions made by radiographers when working on call in an accident and emergency imaging department. An evaluation of the modes of decision making used by radiographers as part of their radiographic clinical practice using participant observation. *Research in Radiography*, *4*(2).

Bowman, S. (1997). Technical evaluation of radiographs: a case study in radiographic judgement and decision-making. In A. Paterson, & R. Price (Eds.), *Current Topics In Radiograph Number 3* (1st ed.) (pp. 69–86). London: W. B: Saunders Company Ltd.

Boyatzis, R. (1998). *Transforming qualitative information: Thematic analysis and code development.* Thousand Oaks, California: Sage.

Brabham, D. C. (2008). Crowdsourcing as a model for problem solving an introduction and cases. *Convergence: the international journal of research into new media technologies*, *14*(1), 75-90.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2). 77-101.

Brewer, J. D. (2000). *Ethnography*. Buckingham: Open University Press.

Brewer, J. D. (2004). "Imagining The Sociological Imagination: The Biographical Context of a Sociological Classic", *British Journal of Sociology*, 55(3), 319–333.

Broadbent, D. E. (1977). The hidden preattentive processes. *American Psychologist, 32*(2), 109-118.

Callister, L.C. (2003). Cultural influences on pain perceptions and behaviors. *Home Health Care Management Practice*, *15*(3), 207–11.

Campbell, J. (2006*). American Pain Society: Advocacy & Policy. Pain: The Fifth Vital Sign*. Retrieved from www.ampainsoc.org/advocacy/fifth.htm

Campbell, E., & Lassiter, L. E. (2010). From Collaborative ethnography to collaborative pedagogy. *Anthropology and Education Quarterly, 41*(4), 370-385.

Cannon-Bowers, J. A., Salas, E., & Pruitt, J. S. (1996). Establishing the boundaries of a paradigm for decision-making research. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 38*(2), 193-205.

Carper, B. A. (1978). "Fundamental Patterns of Knowing in Nursing". *Advances in Nursing Science, 1*(1), 13–24.

Chalmers, A. (1999). *What is this thing called science?* (3rd ed.). Indianapolis: Hackett.

Chipchase, L., & Prentice, C. E. (2006). Expert physiotherapists' clinical decision-making in acute care. Part one. *International Journal of Therapy and Rehabilitation, 13*(8), 343-50.

Christian, L. M., & Dillman, D. A. (2004). The influence of graphical and symbolic language manipulations on responses to self-administered questions. *Public Opinion Quarterly, 68*(1), 57-80.

Coffey, A. (1999). *The Ethnographic Self: Fieldwork and the Representation of Identity*. London: Sage.

College of Radiographers. (2013). Education and Career Framework for the radiography Workforce. London: The College of Radiographers.

Collins, H. M. (1993). The Structure of Knowledge. *Social Research,* 60(1), 95-116.

Corbin, J., & Strauss, A. L. (2008). *Basics of Qualitative Research: Grounded Theory Procedures and Techniques* (3rd ed.). Thousand Oaks CA: Sage.

Corrigan, O., & Tutton, R. (2006). What's in a name? Subjects, volunteers, participants and activists in clinical research. *Clinical Ethics, 1*(2), 101-104.

Couger, J. D. (1995). *Creative Problem Solving and Opportunity Finding*. Danvers, MA: Boyd & Fraser Publishing Company.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks, CA: Sage.

Creswell, J. W. (2002). Analyzing and interpreting qualitative data. In J. Creswell (Ed.). *Educational research,* (pp. 256-283). Thousand Oaks: Sage.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed.). Los Angeles: Sage Publications, Inc.

Crompton, R. (1990). Professions in the current context. *Work, Employment and Society, 4*(5), 147-166.

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process.* California: Sage.

Cruess, R. L., & Cruess, S. R. (1997). Teaching Medicine as a Profession in the Service of Healing. *Academic Medicine, 72*(11), 941-952.

Cruz, E. V., & Higginbottom, G. (2013). The use of focused ethnography in nursing research. *Nurse Researcher, 20*(4), 36-43.

Cudmore, H., & Sondermeyer, J. (2007). Through the looking glass: being a critical ethnographer in a familiar nursing context. *Nurse Researcher, 14*(3), 25-35.

Curtise, K. C., & White, P. (2005). Qualitative research design and approaches in radiography. *Radiography, 11*(3), 217-225.

Cutcliffe, J. R., & McKenna, H. P. (2004). Expert qualitative researchers and the use of audit trails. *Journal of Advanced Nursing, 45*(2), 126–135.

Damen, L. (1987). *Culture Learning: The Fifth Dimension on the Language Classroom.* Reading, MA: Addison-Wesley.

Dane, E., & Pratt, M. G. (2007). Exploring intuition and its role in managerial decision making. *Academy of Management Review, 32*(1), 33-54.

Davidson, C. (2009). Transcription: Imperatives for Qualitative Research. *International Journal of Qualitative Methods, 8*(2), 36-52.

Deiters, P. (2011). *Identity, Agency and the Acquisition of Professional Language and Culture.* London: Continuum International Publishing Group.

Denzin, N. K. (1970). *The research act in sociology*. Chicago: Aldine.

Denzin, N. K., and Lincoln, Y. (2003). *Handbook of Qualitative Research*. California: Sage.

Department of Health. (2013) The Education Outcomes Framework. Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/175546/Education_outcomes_framework.pdf

Department of Health. (2000). *The Ionising Radiation (Medical Exposure) Regulation.* London: TSO. Retrieved from http://www.opsi.gov.uk/si/si2000/20001059.htm (accessed 04.04.11)

DeRoos, Y. S. (1990). The development of practice wisdom through human problem solving Processes. *The Social Service review, 64*(2), 276-287.

Dey, I. (1993). *Qualitative Data Analysis*. London: Routledge**.**

Dorfman, J., Shames, V. A., & Kihlstrom, J. F. (1996). In G. Underwood (Ed.), *Implicit Cognition*, Oxford: Oxford University Press.

Dodge, Y. (2003). *The Oxford Dictionary of Statistical Terms*. Oxford University Press

Dörner, D. (1975). Wie Menschen eine Welt verbessern wollten [How people wanted to improve the world]. *Bild der Wissenschaft, 12*, 48-53.

Dreyfus, S. E., & Dreyfus, H. L. (1980). *A five-stage model of the mental activities involved in directed skill acquisition* (No. ORC-80-2). California University Berkeley Operations Research Centre.

Dreyfus, H. L., & Dreyfus, S. E. (1986). *Mind over machine: The power of human intuition and expertise in the era of the computer.* New York: The Free Press.

Dunwoody, P. T. (2009). Theories of truth as criteria in judgement and decision making. *Judgement and decision making, 4,* 116-125.

DZurilla, T. J., & Goldfried,M.R. (1971). Problem Solving and Behaviour Modification. *Journal of Abnormal Psychology.78,*107-126

DZurilla, T. J., & Nezu, A. M. (1982). Social problem s DZurilla, T. J., & Nezu, A. M. (1982). Social problem solving in adults. In P. C. Kendall (Ed.), Advances in cognitive-behavioral research and therapy (Vol. 1, pp. 201-274). New York: Academic Press. olving in adults. In P. C.

D'Zurilla, T. J., Nezu, A. M., & Maydeu-Olivares, A. (2004). Social problem solving: Theory and assessment. In E. C. Chang, T .J. D'Zurilla, & L. J. Sanna (Eds.), *Social problem solving: Theory, research, and training* (pp. 11-27). Washington, D.C.: American Psychology Association.

Edwards, H. (2006). Critical thinking and the role of the ultrasound clinical tutor. *Radiography, 12*(3), 209-214.

Embrey, D. (2007). "Understanding human behaviour and error," in *Human Error*. Dalton, UK: Human Reliability Associates, Ltd., [Online]. Retrieved from http://zonecours.hec.ca/documents/A2007-1-1399575. UnderstandingHumanBehaviourandError.pdf/ (accessed 09.04.2015)

Epley, N., & Gilovich, T. (2006). "The Anchoring and Adjustment Heuristic: Why the Adjustments Are Insufficient". *Psychological Science*, *17*(4), 311–18.

Ericsson, K. A., & Simon, H. A. (1993). *Protocol Analysis: Verbal Reports as Data*, Revised Edition. London: The MIT Press.

Fetterman, D. M. (1998). *Ethnography* (2nd ed.). London: Sage.

Fikes, R. E., & Nilsson, N. J. (1971). STRIPS: A new approach to the application of theorem proving to problem solving. *Artificial Intelligence, 2*(3), 189-208.

Fingerman. S. (2006). Web of Science and Scopus: Current Features and Capabilities [online]. Retrieved from http://www.istl.org/06-fall/electronic2.html (accessed 01.06.15)

Fink, A. S. (2000). The Role of the Researcher in the Qualitative Research Process. A Potential Barrier to Archiving Qualitative Data Forum Qualitative Sozialforschung / Forum: *Qualitative Social Research, 1*(3), Art. 4. Retrieved from http://nbn-resolving.de/urn:nbn:de:0114-fqs000344 (accessed 09.01.15)

Flanagan, J. C. (1954). The critical incident technique. *Psychology Bulletin, 11*(4), 327–58.

Foody, J. M., Mendys, P. M., Liu, L. Z., & Simpson Jr, R. J. (2010). The utility of observational studies in clinical decision making: lessons learned from statin trials. *Postgraduate medicine, 122*(3), 222-229.

Foley, D. E. (2010). *Deep in the Heart of Tejas (Contemporary Ethnography)*. Pennsylvania: University of Pennsylvania Press.

Foss, S. K., & Waters, W. (2003). Coding and Analysis of Qualitative Data. Retrieved from http://www.abdsurvivalguide.com/News/020603.htm

Ford, P. (2010). The role of the consultant radiographer experience of appointees. *Radiography, 16*(3), 189-197.

Foulcault, M. (1975). *The Birth of the Clinic: An Archeology of Medical Perception*. (A. M. S. Smith, Trans.). New York: Vintage.

Freidson, E. (1986). *Professional Powers: A Study of the Institutionalization of Formal Knowledge.* Chicago: University of Chicago Press.

Gagné, R. M. (1959). Problem solving and thinking. *Annual Review of psychology, 10*(1), 147-172.

Geertz, C. (1973). Thick description: Toward an interpretive theory of culture. *In The Interpretation of Cultures: Selected Essays* (pp. 3-30). New York: Basic Books, Inc., Publishers.

Gerdtz, M. F., & Bucknall, T. K. (2001).Triage nurses' clinical decision making. An observational study of urgency assessment. *Journal of Advanced Nursing, 35*(4), 550-561.

Gerrish, K., & Lacey, A. (Eds.). (2006). *The research Process in Nursing* (5th ed.). Oxford: Blackwell Publishing.

Gigerenzer, G., & Goldstein, D. (1996). Reasoning the Fast and Frugal Way: Models of Bounded Rationality. *Cognitive Science, 103*(4), 650-666.

Glaser, B., & Strauss, A. L. (1967). *The Discovery of Grounded Theory: Strategies for Qualitative Research*. Chicago: Aldine Publishing Company.

Gobet, F., & Chassy, P. (2008). Towards an alternative to Benner's theory of expert intuition in nursing. *Applied Cognitive Psychology,* 19, 183-204.

Goldthorpe, J. (2000). *Sociological ethnography today: problems and possibilities, On Sociology.* Oxford: Oxford University Press.

Golfanshani, N. (2003). Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report, 8*(4), 597-607.

Göransson, K. (2006). *Registered nurse-led emergency department triage: organisation, allocation of acuity ratings and triage decision-making.* (Unpublished PhD thesis), Orebro University, Sweden.

Göransson, K., Ehrenberg, A., Marklund, B., & Ehnfors, M. (2006). Emergency department triage: Is there a link between nurses' personal characteristics and accuracy in triage decisions? *Accident and Emergency Nursing, 14*(2), 83–88.

Greenwood, E. (1957).'The Attributes of a Profession'. *Social work, 2*(3), 44-55.

Grundstein-Armando, R. (1991). An integrative model of clinical-ethical decision making. *Theoretical medicin*e, *12*(2), 157-170.

Guba, E. G. (1981). Criteria for assessing the trustworthiness of naturalistic inquiries. *Educational Technology Research and Development, 29*(2), 75-91.

Guba, E. G. (Ed.). (1990). *The paradigm dialog.* Newbury Park, CA: Sage.

Guest, G., Bunce, A., & Johnson, L. (2006). "How many interviews are enough? An experiment with data saturation and variability". *Field Methods, 18*(1), 59-82.

Habermas, J. (1972) *Knowledge and Human Interests*. trans. Jeremy J. Shapiro.

London: Heineman

Halpern, E. S. (1983). *Auditing Naturalistic Inquiries: The Development and Application of a Model.* (Unpublished PhD thesis), Indiana University.

Hammersley, M., & Atkinson, P. (2003). *Ethnography: Principles in Practice* . London: Routledge.

Hammersley, M., & Atkinson, P. (2007). *Ethnography: Principles in Practice* (3rd ed.). London: Routledge.

Harbison, J. (1991). Clinical decision making in nursing. *Journal of advanced nursing*, *16*(4), 404-407.

Hardin, L. E. (2002). Problem-solving concepts and theories. *Journal of veterinary medical education*, *30*(3), 226-229.

Harding, J., & Davis, M. (2015). An observational study based on the interaction between the paediatric patient and the radiographer. *Radiography.*

Hardy, M. (2000). Paediatric Radiography: is there a need for postgraduate education? *Radiography,* (5), 27-34.

Havard, L. (2007) How to conduct an effective and valid literature search. *Nursing Times, 103* (44), 32–33.

Health Act. (1999). Norwich: The Stationery Office Limited. Retrieved from

http://www.hmso.gov.uk/acts/acts1999/19990008.htm (accessed 4.4.11)

Health and Care Professions Council. (2013). *Standards of Proficiency: Radiographers*, London: Health and Care Professions Council.

Health and Care Professions Council. (2015) Professions. Retrieved 5 May 2015 from http://www.hcpc-uk.co.uk/aboutregistration/professions/index.asp?id=12

Hertz, R. (Ed.). (1997). *Reflexivity and Voice*. Thousand Oaks CA: Sage**.**

Hibbard, J, H. (2004). Moving toward a more patient-centered health care delivery system. *Health Aff* (Millwood);Suppl Web Exclusive:VAR133–135.

Higginbottom, G., Pillay, J., & Boadu, N. Y. (2013). Guidance on performing focused ethnographies with an emphasis on healthcare research**.** *Qualitative Report, 18*(17), 1-16.

Higgs, J., Jones, M., Loftus, S., & Christensen, N. (Eds.). (2008). *Clinical reasoning in the health professions* (3rd ed.). China. Butterworth Heinemann Elsevier.

Hogg, M. & Vaughan, G. (2008). *Social Psychology* **(**5th ed.). London: Prentice Hall.

Holden, R. J. (1991). Responsibility and autonomous nursing practice. *Journal of Advanced Nursing, 16*(4), 398-403.

Hsieh, H. F., & Shannon, S. E. (2012). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research, 15*(9), 1277-1288.

Huitt, W. (1992). Problem solving and decision making: Consideration of individual differences using the Myers-Briggs Type Indicator. *Journal of Psychological Type, 24*(0), 33-44.

Huitt, W. (2003). The information processing approach to cognition. *Educational Psychology Interactive*. Retrieved from http://chiron.valdosta.edu/whuitt/col/cogsys/infoproc.html

Hull, C. L. (1934). The Concept of the Habit-Family Hierarchy and Maze Learning: Part I *Psychological Review*, *41*(1), 33-54.

Hurst, K. (1985). Problem-solving tests in nurse education. *Nurse education today, 5*(2) 56-62.

Israel, G. D. (2006, February). Visual cues and response format effects in mail surveys. In *annual meeting of the Southern Rural Sociological Association*. Orlando Florida.

Janis, I. (1972). *Victims of Groupthink.* Boston, MA: Houghton Mifflin.

Jin, J., Sklar, G. E., Oh, V. M. S., & Li, S. C. (2008). Factors affecting therapeutic compliance: A review from the patient's perspective. *Journal of Thereputics and Clinical Risk Management, 4*(1), 269–286.

Jonassen, D. H. (2000). Toward a Design Theory of Problem Solving. *Educational Technology Research and Development, 48*(4), 63-85.

Jørgensen, K. (2003, November). Problem Solving: The Essence of Player Action in Computer Games. In *DIGRA Conf.*

Kahneman, D. (2011). *Thinking, fast and slow*. London: Penguin.

Kelly, J., Piper, K., Nightingale, J. (2008). Factors influencing the development and implementation of advanced and consultant radiographer practice. A review of the literature. *Radiography, 14*(1), 71-78.

Kiguli-Malwadde, E., Businge, F., & Mubuuke, A. G. (2009). Attitudes and perceptions of students and teachers about problem based learning in the radiography curriculum at Makerere University, Uganda. *European Journal of Radiography, 1*(4), 156-162.

Kihlstrom, J. F. (2008). The automaticity juggernaut. In J. Baer, J. C. Kaufman, & R. F. Baumeister (Eds.). *Are We Free? Psychology and Free Will* (pp. 155-180). New York: Oxford University Press.

Klein, G. (1989). A Recognition-Primed Decision (RPD) Model of Rapid Decision Making. In G. Klein, J. Orasanu, R. Calderwood, & C. Zsambok (Eds.). *Decision making in action: Models and methods*. (pp. 138-147). New Jersey: Ablex Publishing Corporation.

Klein, G., & Klinger, D. (1991). Naturalistic Decision Making. *Human Systems IAC Gateway*, XI, (3), 16-19

Knoblauch, H. (2005). Focused ethnography. *Forum Qualitative Social Research, 6*(3)**,** 44. Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/20/44

Kohli, E., Ptak, J., Smith, R., Taylor, E., Talbot, E. A., & Kirkland, K.B. (2009). Variability in the Hawthorne effect with regard to hand hygiene performance in high- and low-performing inpatient care units. *Infection Control and Hospital Epidemiology, 30*(3), 222-225. doi: 10.1086/595692 (accessed 15.10.13)

Krauss, R. M. (1998). Why do we gesture when we speak? *Current Directions in Psychological Science* 7, 54-59.

Kumar, R. (2005). *Research Methodology: a step by step guide for beginners.* London: SAGE.

Laing, R. D. (1971). *The Politics of the Family and Other Essays*. London: Tavistock Publications.

Lam, D., Egan, I., & Baird, M. (2004). The Radiographer's impact on improving Clinical Decision- making, Patient Care and Patient Diagnosis: A pilot study. *The Radiographer, 51*, 133-137.

Lamb, B., & Sevdalis, N. (2011). How do nurses make decisions? *International Journal of Nursing Studies, 48*, 281–284.

Landsberger, H. A. (1958). *Hawthorne Revisited: management and the worker, its critics and developments in human relations in industry.* Ithaca: Cornell University Press.

Larsson, W., Lundberg, N., & Hillergard, K. (2008). Use your good judgement – Radiographers' knowledge in image production work. *Radiography, 15*(3), 11-21.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge university press.

Levett-Jones, T., Hoffman, K., Bourgeois, S., Kenny, R., Dempsey, J., Hickey, N., & Jeffrey, K. (2009). *Clinical reasoning: Instructor resources*. School of Nursing and Midwifery Faculty of Health, University of Newcastle. Retrieved from http://www.utas.edu.au/__data/assets/pdf_file/0003/263487/Clinical-Reasoning (accessed 14.04.15)

Liberman, R. P., Mueser, K. T., & Wallace, C. J. (1986). Social skills training for schizophrenic individuals at risk for relapse. *American Journal of Psychiatry, 143*(4), 523– 526.

Likert, R. (1932). "A Technique for the Measurement of Attitudes". *Archives of Psychology, 140*, 1–55.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Lipe, S. K., & Beasley, S. (2004). *Critical Thinking in Nursing: A Cognitive Skills Workbook*. Philadelphia, PA: Lippincott Williams & Wilkins.

Lundgren-Lane, H., & Salantera, S. (2009). Think aloud Technique and Protocol Analysis in Clinical decision-making research. *Qualitative Health Research*. Beverly Hills, CA: Sage.

Lundvall, L., Dahlgren, M. A., & Wirrel, S. (2014). Professionals' experiences of imaging in the radiography process – a phenomenological approach. *Radiography, 20*(2), 48–52.

MacGeorge, J. M., & Nelson, K. M. (2003). The experience of the nurse at triage influences the timing of CPAP intervention. *Accident and Emergency Nursing, 11*(4), 234–238.

Mackay, S. (2002). *Interprofessional education: An action learning approach to the development and evaluation of a pilot project at undergraduate level.* (Doctoral dissertation), University of Salford, Salford.

MacGeorge, J. M., & Nelson, K. M. (2003). The experience of the nurse at triage influences the timing of CPAP intervention. *Accident and emergency nursing*, *11*(4), 234-238.

MacLeod, C. M. (1991). Half a century of research on the Stroop effect: an integrative review. *Psychological bulletin*, *109*(2), 163.

Makhathini, J. T. (1992). The problem-solving process with special application to the clinical setting. *Curationis*, *15*(2), 24-26.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice*, *13*(6), 522-525.

Mason, M. (2010, August). Sample size and saturation in PhD studies using qualitative interviews. In *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 11*(3). Retrieved from http://www.qualitative-research.net/index.php/fqs/article/view/1428/3027 (accessed 15.10.13)

Martin, P. & Bateson, P. (2004). *Measuring Behaviour: An introductory guide.* Cambridge: Cambridge University Press.

Mays, N., & Pope, C. (1995). Qualitative research: rigour and qualitative research. *BMJ*, *311*(6997), 109-112. doi: 10.1136/bmj.311.6997.109

McCarney, R., Warner, J., Iliffe, S., van Haselen, R., Griffin, M., & Fisher, P. (2007). The Hawthorne Effect: a randomised, controlled trial. *BMC medical research methodology*, *7*(1), 30. doi:10.1186/1471-2288-7-30.McFall, R. M. (1982). A review and reformulation of the concept of social skills. *Behaviour Assessment*, *4*(1), 1-33.

McLeod, S. A. (2008). *Information Processing*. Retrieved from http://www.simplypsychology.org/information-processing.html

McNamara, C. (2009*). General guidelines for conducting interviews*. Retrieved from http://managmenthelp.org/evauatn/interview.htm (accessed 23.10.13)

McPeck, J. E. (1981). *Critical Thinking and Education*. Toronto: Oxford University Press.

Mezirow, J. (1991). *Transformative Dimensions of Adult Learning*. San Francisco, CA: Jossey-Bass.

Mezirow, J. (1994). Understanding transformation theory. *Adult Education Quarterly*, *44*(4), 222-244.

Miles, M., & Huberman, A. (1994). *Qualitative data analysis* (2nd ed.). Thousand Oaks: Sage Publications.

Morera, O. F., Maydeu-Olivares, A., Nygren, T. E., White, R. J., Fernandez, N. P., & Skewes, M. C. (2006). Social problem solving predicts decision making styles among US Hispanics. *Personality and Individual Differences*, *41*(2), 307-317.

Muecke, M. (1994). On evaluation of ethnographies**.** In J. M. Morse (Ed.), *Critical issues in qualitative research methods* (pp. 187-209). Thousand Oaks, CA: Sage Publications.

Murphy, F. J., & Yielder, J. (2010). Establishing rigour in qualitative radiography research. *Radiography*, *16*(1), 62-67.

Murphy, F., Williams, A., & Pridmore, J. A. (2010). Nursing models and contemporary nursing 1: their development, uses and limitations. *Nursing times*, *106*(23), 18.

Myers, D. G. (1993). *Social Psychology* (4th ed.). New York: McGraw-Hill Inc.

Myers, M. (2000). Qualitative Research and the Generalizability Question: Standing Firm with Proteus. *The Qualitative Report*, *4*(3/4), 1-9. Retrieved from http://www.nova.edu/ssss/QR/QR4-3/myers.html (accessed 23.6.15)

Myers, M. D. (2008). *Analyzing Qualitative Data: An overview*. Sage Publications Limited. Retrieved from www.uk.sagepub.com/.../Chapter_13_-_Analyzing_qualitative_data_-_an overview (accessed 21.1.15)

Newell, A., and Simon, H. A. (1972). *Human problem solving.* Englewood Cliffs, NJ: Prentice Hall.

Newton-Hughes, A., & Murphy, F. J. (2012). *Decisions, Decisions: how do radiographers make them in the trauma setting?* Conference presentation UKRC.

Newton-Hughes, A., & Robinson, L. (2013). *Radiographer assessment of patient mobility in the trauma setting*. E poster UKRC.

Nichols, A. L., & Maner, J. K. (2008). The good-subject effect: Investigating participant demand characteristics. *The Journal of general psychology*, *135*(2), 151-166.

Nickols, F. W. (2000). The knowledge in knowledge management. In J. W. Cortada & J. A. Woods (Eds.). *The knowledge management yearbook 2000-2001* (pp. 12-21). Boston, MA: Butterworth-Heinemann.

Nightingale, J. M., Murphy, F. J., Robinson, L., Newton-Hughes, A., & Hogg, P. (2015). Breast compression–An exploration of problem solving and decision-making in mammography. *Radiography*.

Nixon, S. (2001). Professionalism in radiography**.** *Radiography*, *7*(1), 31-35.

Olesen, V. L., & Whittaker, E. W. (1968). *The Silent Dialogue: A Study in the Social Psychology of Professional Socialization*. San Francisco: Jossey-Bass.

Oliver, D. G., Serovich, J. M., & Mason, T. L. (2005). Constraints and Opportunities with Interview Transcription: Towards Reflection in Qualitative Research. *Social Forces*, *84*(2), 1273–1289.

O'Neill, E. S., Dluh, N. C., & Chun, E. (2005). Modelling novice clinical reasoning for a computerised decision support system. *Journal of Advanced Nursing*, *49*(1), 68–77.

O'Reilly, K. (2008). *Key concepts in ethnography*. Sage.

Ormrod, J. E. (1987). *Human Learning*. Upper Saddle River, New Jersey: Prentice Hall.

Oswal, D., Safferson, D., & Rehman, A. (2009). A study of adequacy of completion of radiology request forms. *Radiography, 15*(3), 209-213.

Parsons, H. M. (1974). What happened at Hawethorne? *Science, 183*(4182), 922-32.

Patai, D. (1994). (Response) When method becomes power. In A. Gitlen (Ed.), *Power and method* (pp. 61–73). New York: Routledge.

Patton, M. Q. (2001). *Qualitative Research and Evaluation Methods* (3rd Ed.). Thousand Oaks, CA: Sage Publications

Pautex, S., & Gold, G. (2006). Assessing pain intensity in older adults. *Geriatrics & Aging*, *9*(6), 399-402.

Pedler, M. (2011) *Action Learning in Practice*, (4th Ed). Farnham: Gower.

Polanyi, M. (1967). *The Tacit Dimension*, New York: Anchor Books.

Price, R. (2001). Radiographer reporting: origins, demise and revival of plain film reporting. *Radiography, 7*(2), 105-117.

Price, R. (2007). *Developing practice in radiography and diagnostic imaging* (Doctoral dissertation), University of Hertfordshire, Hertfordshire.

Prime, N. J., & Le Masurier, S. B. (2000). Defining how we think: an investigation of decision making processes in diagnostic radiographers using the 'think aloud' technique. *Radiography, 6*(3), 169-178.

Rasmussen, J. (1983). Skills, rules, and knowledge: Signals, signs, and symbols, and other distinctions in human performance models. *IEEE Transactions on Systems, Man, and Cybernetics*, SMC, *13*(3), 257-266.

Reason, J. (1990). *Human Error*. Cambridge, UK: Cambridge University Press.

Rice, B (1982). The Hawethorne Defect: Persistance of a flawed theory. *Psychology Today*, *16*(2), 70-74.

Richards, L., & Morse, J. M. (2007). *Readme first for a user's guide to qualitative methods* (2nd ed.). Thousand Oaks, CA: Sage.

Rittle-Johnson, B., & Koedinger, K. R. (2005). Designing knowledge scaffolds to support mathematical problem solving. *Cognition and Instruction*, *23*(3), 313-349.

Roberts, D. (2007). Ethnography and staying in your own nest. *Nurse Researcher*, *14*(3), 4–6.

Robinson, L., Harris, A., & Burton, R. (2015). Saving face: Managing rapport in a Problem-Based Learning group. *Active Learning in Higher Education*, *16*(1), 11-24.

Romney, A., Batchelder, W., & Weller, S. (1986). Culture as consensus: A theory of culture and informant accuracy. *American anthropologist*, *88*(2), 313-338.

Roper, J. M., & Shapira, J. (2000). *Ethnography in Nursing Research* (Vol. 1). Sage Publications.

Rossman, R. B., & Ralllis, S. F. (1998). *Learning in the field: An introduction to qualitative research.* Thousand Oaks, CA: Sage.

Rothman, J. (1997). *Resolving Identity Conflicts in Nations, Organizations, and Communities.* San Francisco: Jossey-Bass.

Royal College of Radiologists and Society and College of Radiographers. (2012). *Team working in clinical imaging.* London: The Royal College of Radiologists and the Society and College of Radiographers.

Royal College of Radiologists (2008). Adequate Completion of Radiology Request Forms. Retrieved from http://www.rcr.ac.uk/audittemplate.aspx?PageID=1020&AuditTemplateID=31 (accessed 01.08.14)

Salas, E., Rosen, M., & Diaz Granados, D. (2010). Expertise-Based Intuition and Decision Making in Organizations. *Journal of Management*, *36*(4), 941-973. doi: 10.1177/0149206309350084

Sams, T. (2006). *ABC's of Pain Relief and Treatment: Advances, Breakthroughs, and Choices*. iUniverse.

Sanchez, J.A. (2012). *Patient Safety*.Philedelphia:Sanders.

Savage, J. (2000). Ethnography and health care. *British Medical Journal*, *321*(7273), 1400-1402.

SCOR. (2005). *A strategy for practice development*. London: The College of Radiographers.

Schaefer, K. M., & Zygmont, D. (2003). Analyzing the teaching style of nursing faculty: Does it promote a student-centered or teacher-centered learning environment?. *Nursing Education Perspectives*, *24*(5), 238-245.

Schegloff, E. (1997).Whose Text? Whose Context? *Discourse & Society*, *8*(2), 165-187.

Schön. D. A. (1983). *The reflective practitioner*. London: Temple Smith.

Schön, D. A. (1986). Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions (1st ed.). San Francisco: Jossey-Bass.

Schutt, R. K. (2012). *Investigating the Social World: The Process and Practice of Research* (7th ed.). Beverly Hills, CA: Sage.

Schwarz, N., Bless, H., Strack, F., Klumpp, G., Rittenauer-Schatka, H., & Simons, A. (1991). Ease of retrieval as information: Another look at the availability heuristic. *Journal of Personality and Social Psychology, 61*(2), 195-202.

Scotland, J. (2012). Exploring the Philosophical Underpinnings of Research: Relating Ontology and Epistemology to the Methodology and Methods of the Scientific, Interpretive, and Critical Research Paradigms. *English Language Teaching, 5*(9). doi: 10.5539/elt.v5n9p9

Scurrah, M., & Wagner, D. A. (1970). Cognitive model of problem solving in chess. *Science, 169*(3941), 209-291.

Senyshyn, Y., & O'Neill, S. (2001). "Subjective Experience of Anxiety and Musical Performance: A Relational Perspective". *Philosophy of Music Education Review, 9*(1), 42-53.

Silverman, D. (2010). *Doing Qualitative Research* (3rd ed.). London: Sage.

Silverman, J., Kurtz, S. & Draper, J. (2005). *Skills for Communicating with Patients* (2nd ed.). Oxford, UK: Radcliffe Pub.

Simmonds, B. (2010). Clinical reasoning: concept analysis. *Journal of Advanced Nursing, 66*(5), 1151-1158.

Simon, H. (1986). *Research briefings: Report of the Research Briefing Panel on Decision Making and Problem Solving*. Washington D.C.: National Academy Press.

Smith, M., Higgs, J., & Ellis, E. (2008). Characteristics and processes of physiotherapy clinical decision making: a study of acute care cardiorespiratory physiotherapy. *Physiotherapy Research International, 13*(4), 209–222.

Society and College of Radiographers (2009) Career Progression Framework. Retrieved from http://www.sor.org/learning/document-library/education-and-professional-development-strategy-new-directions/career-progression-framework-cpf

Society of Radiographers (2015) A Career in Radiography. Retreived 5th May 2015 from http://www.sor.org/about-radiography/career-radiography

Solomon, N., Boud, D., Leontios, M., & Staron, M. (2001). Researchers are learners too: collaboration in research on workplace learning. *Journal of Workplace Learning, 13*(7/8), 274-282.

Spencer, L., Ritchie, J., & O'Connor, W. (2004). Analysis: practices, principles and processes. In J. Ritchie & J. Lewis (Eds.), *Qualitative research practice* (pp. 199 218). London: Sage Publications.

Spiegel, P. K. (1995). The first clinical X-ray made in America—100 years. *American Journal of Roentgenology, 164*(1), 241–243.

Spradley, J. P. (1979). *The ethnographic Interview*. Belmont USA: Wadsworth.

Sternberg, R. J.,(Ed.). (1995). *Encyclopedia of human intelligence*. Macmillan. ISBN 978-0-02-897407-1. OCLC 29594474.

Sternberg, R. J. (2003). *Wisdom intelligence and creativity synthesized*. NY: Cambridge University Press.

Stivaros, S. M., Gledson, A., Nenadic, G., Zeng, X. J., Keane, J., & Jackson, A. (2010). Decision support systems for clinical radiological practice-towards the next generation. *The British journal of radiology*, *83*(995), 904-914.

Strudwick, R., Mackay, S., & Hicks, S. (2011). Is Diagnostic Radiography a Caring Profession? *Synergy (June 2011)*, 4-7.

Strudwick, R. M.., & Day, J. (2014). Interprofessional working in diagnostic radiography. *Radiography*, *20*(3), 235-240.

Taylor, C. (1997). Problem solving in clinical nursing practice. *Journal of Advanced Nursing*, *26*(2), 329-336.

Taylor, C. (2000). "Clinical problem solving in Nursing". *Journal of Advanced Nursing, 31*(4), 842–849.

Taylor, C., & Gibbs, G. R. (2010). How and what to code. Retrieved from onlineqda.hud.ac.uk/Intro_QDA/how_what_to_code.php (accessed 09.01.15)

Teijlingen Van, E., Rennie, A. M., Hundley, V., & Graham, W. (2001). The importance of conducting and reporting pilot studies: the example of the Scottish Births Survey. *Journal of Advanced Nursing, 34*(4), 289-295.

Temur, O. D. (2012). Analysis of Prospective Classroom Teachers' Teaching of Mathematical Modelling and Problem Solving. *Eurasia Journal of Mathematics, Science and Technology Education, 8*(2), 83-93.

Terry, W., & Higgs, J. (1993). Educational programmes to develop clinical reasoning skills. *Australian Journal of Physiotherapy*, *39*(1), 47-51.

The Stationary Office (1998) Data Protection Act. Retrieved from http://www.legislation.gov.uk/ukpga/1998/29/section/1

The Stationary Office (2012)Human Medicine regulations. Retrieved from http://www.legislation.gov.uk/uksi/2012/1916/contents/made

Thorne, S. (2003). Data analysis in qualitative research. *Evidence Based Nursing, 3*(3), 68-70.

Tod, D.A,, Iredale, K.F., Strange, D.E.O., Gill, N., McGuigan, M.R. (2005). "Psyching-up" enhances force production during the bench press exercise. *Journal of Strength and Conditioning Research*, 19 ,599-603

Tugwell, J. (2014). Here Comes a Trolley *Synergy: Imaging & Therapy Practice (September 2014)*, 14.

Tversky, A., & Kahneman, D. (1974). Judgement Under Uncertainty: Heuristics and Biases. *Science, 185*(4157), 1124-1131.

U.S. Government Printing Office. (1949). Trials of War Criminals before the Nuremberg Military Tribunals under Control Council Law. *10*(2), pp. 181-182. Washington, D.C..

Van Gundy, A. B. (1981). *Techniques of Structured Problem-solving.* New York: Van Nostrand Reinhold.

Van Teijlingen, E., & Hundley, V. (2001). The importance of pilot studies. *Social research update*, (35), 1-4.

Wallas, G. (1926). *The art of thought*. New York: Harcourt.

Walliman, N. (2001). *Your Research Project - A Step-By-Step Guide for the First-Time Researcher,* London: Sage.

Walsh, M. (1998). *Models and Critical Pathways in Clinical Nursing: Conceptual frameworks for care planning.* London: Balliere Tindall.

Watt, D. (2007). On Becoming a Qualitative Researcher: The Value of Reflexivity. *The Qualitative Report, 12*(1), 82-101.

Weber, S. J., & Cook, T. D. (1972). Subject effects in laboratory research: An examination of subject roles, demand characteristics, and valid inference. *Psychological Bulletin*, *77*(4), 273-295.

Wenger, E. (1998). Communities of practice: Learning as a social system..*Systems thinker*, *9*(5), 2-3.

Werner, K., & Raab, M. (2013). Moving to solution. *Experimental Psychology*, *60*(6), 403-409.

Whiting, C. (2009). Promoting professionalism. *Synergy (September 2009)*, 4-7.

Wood, D.F. (2003) Problem Based Learning. *British Medical Journal,* 326:328 http://dx.doi.org/10.1136/bmj.326.7384.328

Woodworth, R. S., & Schlosberg, H. (1954). *Experimental psychology* (Rev. ed.). New York: Holt, Rinehart, & Winston.

World Medical Association. (2008). Declaration of Helsinki-Ethical principles for medical research involving human subjects. Retrieved from http://www.wma.net/en/30publications/10policies/b3/

Yates, F. (2001). "Outsider": Impressions of naturalistic decision making. In E. Salas, & G. Klein, (Eds.), *Linking expertise and naturalistic decision making.* Mahwah, NJ: Lawrence Erlbaum.

Yin, R. (2014). *Case study research design and methods* (5th ed). Newbury Park, CA: Sage.

Zeleny, M. (1982). The decision process and its stages. *Multiple Criteria Decision Making* (pp. 84-95). New York: McGraw Hill Book Company.

Web Sites

Oxford Online -Dictionary http://www.oxforddictionaries.com/definition/english/problem

University of Hertfordshire http://www.herts.ac.uk/courses/assistant-practitioners-training-clinical-imaging

Bibliography

Aitken, L. M., Marshall, A., Elliot, R., & McKinley, S. (2010**).** Comparison of 'think aloud' and observation as data collection methods in the study of decision making regarding sedation in intensive care patients. *International Journal of Nursing Studies*. *48*(3), 318–325.

Altman, T. (2007). An Evaluation of the Seminal Work of Patricia Benner: Theory or Philosophy? *Contemporary Nurse*, *25*(1), 114-123.

Anderson, D. R., Sweeney, D. J., & Williams, T. A. (2000). *An Introduction to Management Science: Quantitative Approaches to Decision Making*. South-Western College Publishing.

Attride-Stirling, J. (2001). Thematic Networks: an analytic tool for qualitative research. *Qualitative Research, 1*(3), 385-405.

Baker, S. E., & Edwards, R. (2012). How many qualitative interviews is enough. National Centre for Research Methods Review Paper. Retrieved from http://eprints.ncrm.ac.uk/2273/ (accessed 18.10.13)

Branch, J. L. (2000). The Trouble with Think Aloud: Generating Data Using Concurrent Verbal Protocols. CAIS 2000: Dimensions of a Global Information Science. In Proceedings of the 28Th Annual Conference. Canadian Association for Information Science.

Brehm, J. (1956). Post-decision changes in desirability of alternatives. *Journal of Abnormal and Social Psychology, 52*(3), 384–389.

Bryman, A., & Burgess, R. G. (Eds.). (1994). *Analyzing Qualitative Data*. Routledge, London.

Cader, M., Campbell, S., & Watson, D. (2005). Cognitive Continuum Theory in Nursing Decision-making. *Journal of Advanced Nursing, 49*(4), 397-405.

Carroll, J. S., & Johnson, E. J. (1990). *Decision Research. A Field G*uide. London: Sage.

Cassell, C., & Symon, G. (Eds.). (2004). *Essential guide to qualitative methods in organizational research*. Sage.

Chung, J. Y. M. (2005). An exploration of accident and emergency nurse experiences of triage decision making in Hong Kong. *Accident and Emergency, 13*(4), 206-213.

Coleman, L., & Piper, K. (2008). Radiographic interpretation of the appendicular skeleton: A comparison between casualty officers, nurse practitioners and radiographers. *Radiography, 15*(3), 196-203.

College of Radiographers. (2001). *SCoR Position Statement on Career Progression.* London: The Society and College of Radiographers.

Connelly, F. M., & Clandinin, D. J. (1990). Stories of experience and narrative inquiry. *Educational Researcher, 19*(5), 2-14.

Creswell, J. W. (2007). *Qualitative Inquiry and Research Design: Choosing among five approaches* (2nd ed.). Sage.

Crouch, M., & McKenzie, H. (2006). The logic of small samples in interview-based qualitative research. *Social Science Information, 45*(5), 483-499.

Curry, B., & Moutinho, L. (1994). Intelligent Computer Models for Marketing Decisions. *Management Decision, 32*(4), 30-35.

Curry, L. A., Nembhard, I. M., Bradley, E. H. (2009). Qualitative and Mixed Methods Provide Unique Contributions to Outcomes Research. *Circulation, 119*(10), 1442-1452.

Darbyshire, P. (1994). Skilled expert practice: is it 'all in the mind'? A response to English's critique of Benner's novice to expert model. *Journal of Advanced Nursing, 19*(4), 755–761.

David, R. A., & Rhee, M. (1998). The Impact of Language as a Barrier to Effective health care in an underserved Hispanic community. *Mount Sinai Journal of Medicine, 65*(5&6), 393-7.

Denzin, N. K., &Lincoln, Y. (1994). Introduction: Entering the field of qualitative research, In *Handbook of Qualitative Research*, California: Sage.

Dealt, K. M., DeWalt, B. R., & Wayland, C. B. (1998). "Participant observation." In H. R. Bernard (Ed.). *Handbook of methods in cultural anthropology* (pp. 259-299). Walnut Creek, CA: Alta Mira Press.

Dreyfus, H. L. (1987). Misrepresenting human intelligence. In *Artificial Intelligence* 4 Bom, R. (ed.). (pp. 1-54). Qoom Helm, Beckenham, Kent: Qoom Helm.

Eddy, D. M. (1984).Variations in Physician Practice: The role of Uncertainty. *Health Affairs, 3*(2), 74-89.

English, I. (1993). Intuition as a function of the expert nurse: a critique of Benner's novice to expert model. *Journal of Advanced Nursing, 18*(3), 387–393. doi: 10.1046/j.1365-2648.1993.18030387

Evans, J. S. B. T. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology, 59*, 255-278.

Festinger, L., Riecken, H. W., & Schachter, S. (1956). When Prophecy Fails. A Social and Psychological Study of a Modern Group that Predicted the Destruction of the World. Minneapolis, MN: University of Minnesota Press.

French, J. R. P. (1950). "Field Experiments: Changing Group Productivity," In J. G. Miller (Ed.). *Experiments in Social Process: A Symposium on Social Psychology* (p. 82). New York: McGraw-Hill.

French. J. R. P., & Raven. B. (1968). *The bases for social power.* In D. Cartwright (Ed.). *Studies in Social power,* Ann Arbor. Michigan: University of Michigan Press.

Gambling, T. S., Brown, P., & Hogg, P. (2003). Research in our practice - a requirement not an option. *Radiography, 9*(1), 71-76.

Geertz, C. (1990). *Works and Lives: The Anthropologist as Author*. Stanford, California: Stanford University Press.

Gilgun, J. F. (2010). Reflexivity and Qualitative research. *Current Issues in Qualitative Research, 1*(2), 1-8.

Gold, R. L. (1958). Roles in sociological field observations. *Social Forces, 36*(3), 217-223.

Groenewald, T. (2004). A Phenomenological Research Design Illustrated. *International Journal of Qualitative Methods, 4*(1), 1-25.

Hamm, R. M. (1988). Clinical Intuition and Clinical Analysis: Expertise and the Cognitive Continuum. In. J. Dowie & A. Elstein (Ed.). *Professional Judgment: a reader in clinical decision making.* Cambridge: Cambridge University Press.

Hammond, K. R. (1978). Towards increasing competence of thought in public policy formation. In K. R. Hammond (Ed.). *Judgement and Decision in Public Policy Formation*. (pp. 11-32). Boulder, C: Westview Press.

Hardy, D., & Smith, B., (2008). Decision Making in Clinical Practice .B*ritish Journal of Anaesthetic and Recovery Nursing, 9*(1), 19-21.

Harvard, L. (2007). How to conduct an effective and valid literature search. *Nursing Times, 103*(45), 32-33.

Herrmann, E., Call, J., Hernandez-Lloreda, M.V., Hare, B., & Tomasello, M. (2007) Humans Have Evolved Specialized Skills of Social Cognition: The Cultural Intelligence Hypothesis. *Science, 317*(5843), 1360-1366. doi: 10.1126/science.1146282

Hogarth, R. M. (2001). *Educating intuition*. Chicago: University of Chicago Press.

Kirk, J., & Miller, M. L. (1986). *Reliability and Validity in Qualitative Research*. London: Sage.

Kluckhohn, C. (1949). *Mirror for man: The relation of anthropology to modern life*. New York: Whittlesey House Inc.

Kollemorten, I., Strandberg, C., Thomsen, B. M., Wiberg, O. Windfeld Schmidt, T., Binder, V., … Riis, P. (1981). Ethical aspects of clinical decision-making. *Journal of medical ethics, 7*(2), 67-69.

Kvale, S. (1996). *Interviews: An Introduction to Qualitative Research Interviewing.* Thousand Oaks California: Sage

Lee, M. B., & Brysiewicz, P. (2009). Enhancing problem solving and nursing diagnosis in year III Bachelor of Nursing students. *Nurse Education Today*, *29*(4), 389-397.

Lewis, C. H. (1982). *Using the" thinking-aloud" method in cognitive interface design*. IBM TJ Watson Research Center.

Lessard, C., Contandriopoulos, A. P., & Beaulieu, M. D. (2009). The role of economic evaluation in the decision-making process of family physicians: design and methods of a qualitative embedded multiple-case study. *BMC family practice*, *10*(1), 15.

O'Cathain, A., Munro, J., Armstrong, I., O'Donnell, C., & Heaney, D. (2007). The effect of attitude to risk on decisions made by nurses using computerised decision support software in telephone clinical assessment: an observational study. *BMC medical informatics and decision making*, *7*(1), 39.

Offredy, M., Kendall, S., & Goodman, C. (2008). The use of cognitive continuum theory and patient scenarios to explore nurse prescribers' pharmacological knowledge and decision-making. *International journal of nursing studies*, *45*(6), 855-868. doi: 10.1016/j.ijnurstu.2007.01.014

Ousey, K., & Johnson, M. (2007). Being a real nurse- concepts of caring and culture in the clinical areas, *Nurse Education in Practice*, 7(3), 150–155.

Powell, M. (1990). Knowledge and Professional Power: the question of control In J. McMorland (Ed.), *The Universities and the professions: partners in enhancing professional practice?* (pp. 43-53). Aukland: University of Aukland.

Punch, K. (1998). *Introduction to Social Research: Quantitative and Qualitative Approaches.* London: Sage.

Sbaih, L. C. (1998a). Initial Assessment in the A&E department. *Accident and Emergency Nursing*, *6*, 2-6.

Sbaih, L. C. (1998b). Initial Assessment: gaining impressions and 'normal cases'. *Accident and Emergency Nursing*, *6*(2), 70-74.

Schuman, J. H., & Alfandre, D. (2008). Clinical ethical decision making: the four topics approach. *Seminars in medical Practice, 11,* 36-42.

Serrant-Green, L. (2007). Ethnographic research. Nurse Researcher, *14*(3), 4-6.

Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, *22*(2), 63–75.

Slevin, E. & Sines, D. (2000). Enhancing the truthfulness, consistency and transferability of a qualitative study: utilising a manifold of approaches. *Nurse Researcher*, *7*(2), 79-98.

Sorrel, J. M. & Redmond, G. M. (1995). Interviews in qualitative nursing research: differing approaches for ethnographic and phenomenological studies. *Journal of Advanced Nursing*, *21*(6), 1117-1122.

Spradley, J. P. (1980). *Participant observation*. New York: Holt, Rinehart and Winston.

Standing, M. (2008). Clinical judgement and decision-making in nursing - nine modes of practice in a revised cognitive continuum. *Journal of Advanced Nursing***,** *62*(1), 124-134.

Strauss, A., & Corbin, J. (1990). *Basics of Qualitative Research*. London**: S**age Publications.

Willig, C. (2001). *Introducing qualitative research in psychology: Adventures in theory and method.* Buckingham Philadelphia: Open University Press.

Wolcott, H. F. (2009). *Writing up Qualitative Research.* London**: S**age Publications.

Appendices

Appendix 1a: Introduction to the researcher

This chapter will introduce myself as the researcher and consider how who I am will influence the research process I use, the participants I work alongside and the way I analyse the data.

Having introduced the subject area I wish to study, it is important to note that the research will be conducted from the perspective of the researcher. In order for others to understand my research it is important that I explain the perspective I take upon the questions raised. It is also essential to consider any subjectivity (unintentional bias) (Kumar 2005) inadvertently introduced into the project as a result of my beliefs and understanding of the world. We should also consider the nature of reflexivity and how my research will affect and change me and how I will affect and change my research. It must be recognised that I will change while conducting the research (the research will change me) and how I conduct and interpret the research may change as the research progresses (Gilgun 2010).

Background

As a child I was brought up in a middle class family in the North-West of England. My father was a bright child and despite a working class background had gained entry into a local grammar school. His aspirations went above those of his background; he strove to improve his outlook and rose to a very senior rank within the fire service. My mother came from a similar background working in skilled but not professional roles during her years of employment. As a result of their efforts I grew up in a middle class family which valued education. My childhood was strictly ordered, as the fire service was structured akin to any military service, and my father would be considered strict by today's standards.

I grew up with strong moral and ethical values, a keen sense of right and wrong and an interest in helping others. My father's rise through the fire service meant that we regularly moved house and we did not stay in one place for more than eighteen months until I was nine years old. I think this has helped me to develop a very relaxed approach to life, I do not remember being troubled by the constant sense of change.

As part of my studies on this path to gaining a Doctorate I have learnt many other things about myself. I already knew that I am a pragmatist and my preferred learning style reflects this. According to my enneagram (http://www.enneagraminstitute.com/TypeThree.asp) I am an achiever, self assured charming and ambitious. My leadership style is "country club"

(Blake and Moulton 1964), more concerned with the people I am working with than the work to be undertaken.

Education

At the age of ten I gained entry into a local Catholic grammar school, educated by nuns from an international order. Academic success was paramount at the school and again moralistic beliefs and behaviours were enforced. My progress at school was monitored in terms of the performance of others both within school and my family. I was, and still am, constantly driven to be or do the best I can, these days it is me who drives the process and I am my harshest critic.

I became a person driven by academic success, working within strict regulations to achieve success. My interest lay in the field of science, studying Biology, Chemistry and Physics at A level. It is perhaps not surprising that from a childhood imbued with regulation and science I went on to study Radiography, a profession steeped in positivism.

Radiography

I trained to be a radiographer in the 1980s when radiography was not a degree profession but a Diploma level qualification (Price, 2007). The learning of knowledge and skills was the chief focus of study. Scant attention was paid to the 'softer' skills. Even after 28 years I can still remember my "patient care" lessons where I was taught to move a patient and the names of surgical instruments. "Patient care" lessons did not include communication, psychology or any similar skills, rather it focused on the equipment needed to care for the patient. This was not an uncommon experience, academic colleagues having noted the same (Robinson, 2011).

Ultrasound

As a radiographer I was less interested in the patients than in the acquisition of the images of them. I was professional but distant with patients. I went on to train to carry out ultrasound examinations, predominantly working in obstetrics and it is here that I first experienced decision dissonance (Zeleny, 1982). I was making important decisions and began to question my own ability and judgements. I did not know that this was a common occurrence in decision making as outlined by Festinger et al. (1956).Until this point in my career I had followed regulation and direction in my work with a lack of autonomy in my practice. I became uncomfortable with my new autonomy, part of this was related to the fact that obstetric ultrasound has the highest litigation rate in medical imaging.

I was also required to break bad news to patients regarding whether the fetus was viable, demised, normally structured or abnormally structured and I think that it was at this time in my career that I became a more human professional. Dealing with the emotions of my patients (and my own) raised my awareness of 'others' and I developed a level of empathy with my patients which I now feel had been lacking in my earlier career. At the same time my personal life was evolving and I became a mother, another event which changed my awareness of others.

Lecturer

Since being a student radiographer I had always wanted to teach, and when the opportunity arose I took on the role of a clinical tutor (practice mentor). I spent a brief time in this role until I joined academia thirteen years ago. I am now responsible for the clinical education of undergraduate radiography students. As I grew within the profession I began to recognise the shortfalls in my own education. I want the current students that I, and others, teach not just to be radiographers, but to be able to be human, I feel that the current culture of radiography does not emphasise this enough and I want to change this. I hope that this research will go some way towards facilitating this change in culture.

I want to help radiographers make decisions. I have seen students struggle with problem solving and decision making and fail to progress in clinical practice as a result, indeed I have struggled with the problem-solving process myself. I believe the knowledge I have gained while completing this study will be of benefit to radiographers making decisions in clinical practice and will help them act as autonomous practitioners as the profession advances. I want this not simply for the members of my profession but also for the patients they care for in their daily roles.

Researcher

Having spent my early life and career in a strictly governed arena, I am now coming to terms with the fact that I may not be comfortable there. A recent review of my research history has demonstrated to me that my work to date has all been qualitative in nature, quite a marked difference from most of the research within my profession. It appears that I am not positivist by nature despite having been 'brought up' in a positivist environment. I find identifying myself difficult as a result and my work often reflects this, frequently switching between a positivist and post-positivist style. I have often switched between referring to myself as 'the

researcher' and 'I' in the work I have completed so far, an unintentional revelation of the conflict within.

How would these factors influence my current research?

Being a qualitative researcher allows you to work with people rather than with equipment and numerical data as a quantitative researcher might. I am most comfortable around people. I need to feel part of the team. If I am working alone in my office I have to get up at regular intervals to speak to somebody else. I do not like to be alone for too long. Some elements of qualitative research do not require direct contact with others; questionnaire, covert observation etc., however others do (Spradley 1979, Wolcott 2009). My personality type and leadership style have had an undoubted influence on my choice of data collection. I want to be with people and the only way to achieve this is by direct observation or interview and I have used both of these methods in my study. However I would have to overcome some barriers in order to become part of the group of participants I observe.

I am a lecturer and the lead for clinical practice for my programme, many of my participants may be my past students. I needed to consider how the radiographers would feel when I observed their practice. Would they feel intimidated and that I am judging them and their decisions? I had to find a way to dispense with these notions to allow me to integrate fully and minimise the Hawethorn effect (French 1950).I presented my research to the group before asking for volunteers, taking pains to explain that I was not interested in the decision that was reached but simply in the process that informed the decision. I gained their trust over a period of weeks by joining them in their casual conversations while waiting for imaging rooms to become free, and by sharing information about my own professional and personal life.

I already have an understanding of radiography and its practice. I would need to step back from this knowledge to ensure that as a researcher I developed an understanding from the participants' perspective and not my own. The radiographer may be doing something for a completely different reason to the rationale I would have for the same act and I could take the meanings of their actions for granted but had to ensure that I understood why they behaved as they did. I had to question practice which the radiographers may assume is part of basic radiographic knowledge and that may undermine my credibility as a lecturer. I tried to diffuse this issue by explaining clearly why I was asking those types of questions before expecting a response.

Appendix 1b: Information sheet and consent form

Information sheet

Dear Radiographer,

I am lecturer and radiographer from the University of Salford. I am currently conducting research into how radiographers make decisions in the clinical setting. I am interested in the process a radiographer undertakes to make a decision not in the decision reached. I am particularly interested in decision making in appendicular trauma examinations.

I am writing to inform you of this work and seek your consent in participating in the study.

To help understand the decision making process radiographers use I would like to watch radiographers undertake imaging examinations for patients with appendicular trauma. Having watched you make decisions related to this I would like to discuss with you how the decision was reached. Each observation will last for the duration of the patient examination (typically 5-15 minutes) which will be dependent upon the individual patient. The discussion following the examination will last approximately 5 minutes. I will be present in the department for blocks of time (days/weeks) and the number of observations I make of you within a day/week will vary with the number of relevant patient examinations you conduct in that day.

It would also help inform the study to know, your sex, age, how long you have been qualified and what training you have undertaken since qualification.

I will record my thoughts about the decision making process I have observed and my discussion with you on a digital audio recorder. The recording will be downloaded onto a password protected computer the same day and securely stored, then transcribed into a password protected document at a later date.

On completion of the consent form, you will be allocated a study number and this will be record with each examination you undertake that I observe. In this way, should you wish to have data from observation of your practice removed from the study it can be identified. It will be possible to hear the recordings of observation of your practice at any time during the study. Should you wish to withdraw from the study you can do so at any time without giving any reason.

Patients will not be asked for written consent for observation of their examination. A poster will be displayed which explains my presence in the department and you should ask the patient for consent to allow me to observe the examination.

I have gained approval to conduct this research from the University of Salford, The National Research Ethics Service and your Trust.

As a member of your profession I have a duty of care to the public. Should I observe any unsafe or unprofessional practice I will discuss my concerns with the departmental manager.

If you have any questions in relation to this study please do not hesitate to contact me on 0161 295 2078 or by email at a.newton-hughes@salford.ac.uk

If you are willing to participate in this study could you please sign to give consent and complete the demographic data requirements on the following page.

Thank you for your time.

NAME

CONSENT FORM

Title of Project: Radiographer decision making in appendicular trauma radiography

Name of Researcher: Ann Newton-Hughes University of Salford

I confirm that I have read and understand the information sheet dated 14.05.12 for the above study and I have had the opportunity to ask questions.

I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason.

I agree to take part in the above study

Name	Date	Signature

Researcher	Date	Signature

1 for participant, 1 for researcher

Date……

DEMOGRAPHIC SURVEY QUESTIONS

1. Sex (circle as appropriate)
   Male

   Female

2. Age range (circle as appropriate)

   20-30 years

   31-40 years

   41-50 years

   51-60 years

   61-70 years

3. Number of years post-registration:

4. Post registration qualifications and training:

Appendix 1c : Patient Notice

Patient Notice

A researcher from the University of Salford is observing the practice of our radiographers today.

When you enter the room, you will be asked if you will allow them to watch your examination.

If you have any questions about the observation please ask.

Appendix 1d: Examples of interview questions

Introducing question e.g. *"Ok so do you think you made a decision at all then?"*

radiographer 1 patient 3

Follow-up question e.g. "*Yeah ok"* radiographer 1 patient 2

Probing questions e.g.- "*Well, I, I , do you think you thought about things more then than you have done with the previous cases"* radiographer 1 patient 5

Specifying question e.g. "*This (person) when you had done (their) AP shoulder and then you reviewed it, you told me before you had started that you would do that, is that something you routinely do, is there a time when you wouldn't do that or do you do that with every shoulder?"*

radiographer 21 patient 5

Direct question e.g. *"ok, you reviewed your ankle after you had done the first two images, so why was that, was that?"* radiographer 21 patient 4

Indirect questions e.g. – *"and I am trying to decide if reviewing their images influences their behaviour for their next image"* radiographer 2 patient 5

Structural question e.g. "*Ok so I want to ask a different question to last time which is why did you use that room rather than this one because they were both free"* radiographer 1 patient 2

Interpreting questions e.g. - *"OK so you think the previous experience with more fragile individuals has affected your practice"* radiographer 2 patient 2

These types of questions were used to gather as much information as possible about the decision process undertaken by the radiographer. There were also occasions when I first started interviewing that I asked a leading question;

Leading question e.g. – *"Ok , so, you have said that, part of it has been, you're looking at the history so she has not had any trauma, so that is a big clue, you know, that (they) could co-operate and part of it was your experience, what do you mean , was it just a , was that a feeling or did you think back to other times when something similar had happened and you knew that you could do it then"*

radiographer 1 patient 6

Appendix 1e: Early field notes

Radiographer 1 patient 1

PT in bed-Pt has dementia

NOTES

Done in CR room

Review card- patient on bed with dementia

Protocols for justification- *I saw these, thus decisions about projections are eliminated as no need to decide*

History-Patient with dementia-makes study 1 think it may be a challenging examination

IN ROOM

Walks to patient- introduces self- Id of patient

This made me wonder what to do if patient can't consent to me watching?

Staff carer with patient.

Centred

Reviewed position

Individual IRs due to CR room

Pt reassured not to be moved from bed

Radiographer 1 patient 2

Pt child injured knee hopped into room with parent

NOTES

Reviewed card- child with injured knee ? patella

CR room- smaller room with decorations on wall for children (other room has similar)

Compliant patient able to get on bed with assistance

Study1 straightens and moves child's leg

Study 1 places leg on pad while chatting with patient

There is no consideration of the individual projections or order of examination and no consideration of image review

Appendix 1f: Systematic field notes

Radiographer 1 patient 8

PT- pt for rt shoulder-pt presents semi erect on stretcher

NOTES

In room 2 CR

Rad asks pt about range of movement

Proj 1

Ap

Rad asks pt to sit forward and supports the IR beneath the shoulder

Rad guides pts arm into position- asks if pt is ok/comfort check - this is a slow process

Develops image but does not review

Proj 2

Uses grid

Asks pt if can lie flat

Tries but abandons attempt to lie flat

Rad turns pt oblique on trolley

Reviews images

Proj 1 again with pt more erect

Appendix 1g: Early interview questions transcription

Radiographer 20 patient 2 transcriptions

Q. Erm for this one you had an ankle and a foot to x-ray and you decided to do the Ankle first ,

A. yeah

Q. why was that?

A. (Pause 5 seconds) I just find it easier to do the ankle first

Q. Why is that, is it..?

A. More convenient for me

Q. right

A. and I can see if they can push their toes back or not as well and they can put their foot flat for the , for the foot xrays as well

Q. ok so you are sort of suggesting it gives you a bit more information about how well they will be able to do the foot by doing the ankle first?

A. Yeah

Q. Ok erm and you asked the patient how they had done it, why did you do that?

A. I just wanted to see if the mechanism of injury as well, just they don't give us much information on the request card, it says inversion injury but have they put all their weight onto it or is it just a slight slipped on the road or something like that

Thank you

Appendix 1h: Later interview questions transcriptions

Radiographer 24 patient 1 observation

Q. Erm when you brought the patient into the room, despite their leg being in a splint they were waving it around in the air, there are two questions I want to ask you, one is did that influence your choice of how to position *(them)*, so do you want to answer that bit

A. Erm well I knew *(they) (they), (they)* didn't seem to have a problem with pain but the main worry was sort of like exacerbating the erm the injury, like erm I had no idea at that point, I mean I can see it looked a bit deformed erm but I had no idea until I saw like the AP xray but erm , yeah I think I decided at that point that I was going to try and get pads underneath it you know for the, for the lateral so

Q. Ok, the other question I was going to ask you was, was, did you visually inspect it and did that give you any cues as to how much you wanted *(them)* to move

A. I , when I initially saw *(them)* in the waiting area, yeah I had a look it there, as I was saying, I could see it was quite deformed and erm I decided to sort of like try and take it easy from there if I could ,with positioning, but I think *(they)* had already decided *(they)* was going to position it himself anyway

Q. Laughs, Yeah *(they)* was very co-operative wasn't *(they)*?

A. Yeah you don't usually get that- laughs

Q. Ok You used room 12, why did you use room 12?

A. Erm, Just to free this room up, I knew there was like a chest already coming in here, so I mean I, I am happy enough to use either room

Q. Ok, And you did the AP first, do you always do the AP first?

A. Erm generally yeah if I can, erm I know a lot of people just tend to go with like ,like the lateral straight away but I always, I just want to see that the joint straight away first of all if I can

Q. Ok so you do the AP first so that you can see the joint space?

A. Yeah

Q. Do you always review your first image before you do your second one, because that is what you did with this patient?

A. Not always it depends on the the urgency of it and erm also the waiting list as well you know you always try and erm but with something like that in general you would you know try and review the AP first I guess

Q. Ok, so does that inform what you do next or is that why you review it

A. yeah

Q. or do you review it for a different reason?

A. Er well just to you know basically see what is going on type thing and what erm I mean , a lot of the time you get, I wouldn't say you get your timewasters in or anything like , but you know straight away type thing if they have not injured it, you have a good idea, I mean it's very , I would say about 9 patients out of 10 where you are wrong and it turns out to be a really bad fracture and you have guessed it wrong erm but yeah I guess so

Q. OK what skills do you use to guess whether they have injured it or not?

A. Erm, just patient assessment, communication, what level of pain they have, what they have done exactly, I ask them allot of the time to describe a mechanism of injury, how they have done it, what they have, you know, like in *(their)* case *(they)* has just fallen downstairs and it could have gone all ways by then, erm, inverted it and everted it, erm also erm you can't really go off erm doctors descriptions, I think here is like really bad in terms of what they put on request cards details and stuff whereas other places I have gone they will describe it in detail like the mechanism of

Appendix 1i: Attendance schedule

DAY	DATE	TIMES
SITE 1		
Friday	4th May	9.30- 12.30pm
Monday	14th May	9.30 – 3.30pm
Tuesday	15th May	9.30 – 3.30pm
Thursday	6th June	9.30 – 3.30pm
SITE 2		
Thursday	11th October	9.30am - 4.30pm
Tuesday	16th October	9.30am - 4.30pm
Thursday	18th October	5.00pm – 12.00 midnight
Tuesday	23rd October	9.30am - 4.30pm
Friday	26th October	9.30am - 4.30pm
Sunday	28th October	10.00am – 4.00pm
Tuesday	30th October	9.30am - 4.30pm
Friday	9th November	2.30pm - 8.00pm
Saturday	10th November	10.00am – 2.00pm
Monday	12th November	1.00pm – 4.30pm
Wednesday	14th November	1.00pm – 4.30pm
Monday	19th November	9.30am - 4.30pm
Tuesday	20th November	9.30am - 4.30pm

Wednesday	21st November	9.30am - 4.30pm
Monday	28th November	9.30am - 4.30pm
Tuesday	29th November	9.30am - 4.30pm
Wednesday	30th November	9.30am - 4.30pm
Monday	3rd December	9.00am – 1.00pm
Tuesday	4th December	10.00am – 3.00pm
Tuesday	11th November	10.00am – 3.00pm

Appendix 1j: Table of radiographer data

Sex	Age	Years post qualification	Additional training
F	20-30 yrs	7	PgC Mammography,IV canulation,MRI,CT,
F	41-50 yrs	9	
F	41-50yrs	4	QA lead, Assessor, Union Learning representative
M	31-40yrs	10	MSc Image Interpretation
M	41-50yrs	12	
F	31-40yrs	11	PgDip Salpingography, in house sailography
F	31-40yrs	16	MRI scanning
F	20-30 yrs	4	
F	31-40yrs	8	Ongoing PgDip Reporting
F	20-30yrs	3	Ongoing Pg Salpingography
F	51-60yrs	6	
F	41-50yrs	19	
F	41-50yrs	20	PgDip Ultrasound
F	20-30yrs	2	
F	31-40yrs	7	In house IVU and IV cannulation
F	20-30yrs	3	
F	41-50yrs	9	In house paediatric training
F	41-50yrs	12	
F	51-60yrs	32	PgDip Image interpretation
M	31-40yrs	4	Red dot training
F	20-30yrs	1.5	
M	30-40yrs	5	IR Rep

Appendix 1k: Reflective diary extracts

14.05.12

"Rads rapidly assess patient movement via discussion and observation both of the normal patient movement (into room etc) and of injured body part.- who teaches this, who also does this?

This informs the decision before they even get in the room."

I made these notes following the observation of a radiographer who greeted the patient at reception and watched them take a seat in the waiting room. Until this point I thought my work was chiefly centred on what happened in the x-ray room but I could see that the radiographer was assessing the patient as they moved away from reception. Were they assessing them as they walked into the room? Is assessment key to this process of problem-solving?

15.05.12

Study 1 – initial discussion of research. Study one suggests that Baylors curve is narrow in radiography since there are a limited number of examinations and a limited number of ways of conducting them, hence experience in an area quickly builds and can move to mature intuition quickly.

I made these notes following a conversation with study 1 who suggested that experience helps develop skills but experience can be built quickly.

17.06.14

When trying to explore the concept of patient assessment for movement I stumbled upon the term "clinical gaze" this is a concept which describes the focus of the medical profession upon the injured part with less emphasis on the patient as a whole. I began to wonder if this was evident in the radiographers practice. I had noted that questioning the patient had a more frequent number of comfort checks in complex cases than in routine. Were the radiographers using a clinical gaze for routine examinations? I don't think this can be derived from the observational data alone, I will need to look at the interview data for this. The nursing gaze is a recognised term, have I discovered the "radiographers gaze"?

01.07.14

Use of the colour codes demonstrated a visual change in the colours applied to the observations as the examinations varied in complexity. As the complexity of the cases increased the colours changed to reflect a change in practice for example, more communication for comfort checking was used, the radiographers were less inclined to position the patient and asked the patient to move themselves or got assistance from an escort.

I made these notes when I had reviewed all the data codes and was looking for themes in the data. I had not noticed this while the examinations were being conducted but the use of colours when coding the data provided a clear visual signal but I needed to confirm this impression by tabulating the data

Appendix 2a: Table of observations

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 1 patient 1		Yes-dementia	Hand-no	Yes-bed	Complex		CR	P M AP	Some elements automatic/ thought through
Radiographer 1 patient 2	Yes		Knee-no		Intermediate		CR	M C P	Automatic
Radiographer 1 patient 3			Hand -no		Routine	Calls it standard	DR		Automatic
Radiographer 1 patient 4	Yes		Toe-no		Intermediate	Would have brought mother in if had any concerns		P	
Radiographer 1 patient 5	Yes	Yes-very young	Tib and Fib-no		Complex	I did take into account the fact that the child was erm slightly upset erm the age of the child as well	DR	M SO	Thought through
Radiographer 1 patient 6			Shoulder -yes		Intermediate	I believed that *(they)* actually could do the examination	CR	M SOD C AP	Thought through
Radiographer 1 patient 7			Finger-no		Routine		CR	SOD AP	Automatic

Radiographer 1 patient 8			Shoulder -yes	Yes-trolley	Complex	**that was a more complicated examination** Yeah yeah I know	CR	P C F AP	Automatic but didn't work acknowledges it should have been thought through
Radiographer 1 patient 9	Yes		Ankle-no		Intermediate	I made a decision that the child was capable and competent and erm to come into the room by herself so I suppose I made that decision but apart from that it was a quite routine	CR	M F AP	Automatic
Radiographer 1 patient 10			Shoulder and forearm-yes		Intermediate	because it was such a vague request they have asked to image quite allot of the upper arm and so what I was trying to assess with that point as to if there was a particular focal point ....of pain	DR	M SOD C I AP	
Radiographer 1 patient 11			Knee in splint-yes	Yes-bed	Complex	I wasn't going to risk any type of injury to *(them)* when *(they)* when *(they)* was in a fragile, in a fragile state	CR	SO P F AP	

Radiographer 1 patient 12	Yes		Wrist - no		Intermediate	potentially it could be a more challenging examination because it could be more painful for *(them)* to move *(their)* arm/wrist	DR	M SO I AP	Thought through
Radiographer 1 patient 13			Finger- no		Routine	I made the judgement call that I could with, in in safety move the finger to gain optimal, optimal optimal positioning		M F	Automatic
Radiographer 1 patient 14			Wrist-no		Routine	I believe the patient was able erm to perform a lateral		M C I	Automatic

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley /chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 2 patient 1			Ankle and foot - no		Routine		CR	SOD M F	Automatic
Radiographer 2 patient 2			Hand and wrist-no		Routine		CR	M P I	Automatic
Radiographer 2 patient 3	Yes		Wrist in sling-no		Intermediate *Rad says routine	there was no requirement for any adapted technique, the patient was quite fit, erm *(they)* understood what I was saying to *(them)*	DR	M SOD I	Automatic
Radiographer 2 patient 4		Yes-compliance	Elbow-yes	Trolley-yes	Complex	I didn't know how much the patient could move the arm and I really didn't realise *(they)* would be in kind of a stupor		M F	Thought through
Radiographer 2 patient 5			Foot and elbow		Routine *Turned out to be intermediate	I didn't want to disturb anything that was already going on and I did ask the patient if *(they)* could straighten *(their)* elbow, when *(they)* said 'no' that is when I decided to adapted technique	DR	SO P M F	Thought through

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 3 patient 1			Ankle in splint-no	Trolley-yes	Intermediate		CR	L P F AP	
Radiographer 3 patient 2			Hand -no		Routine		CR	SOD M F AP	Automatic
Radiographer 3 patient 3			Finger-no		Routine		CR	SOD M F AP	Automatic
Radiographer 3 patient 4			Tib and fib-no		Routine	that *(they)* could move about on crutches and they were obviously happy for *(them)* to be on crutches so *(they)* could weight bear a bit	CR	M F AP	

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 4 patient 1			Knee- no	On crutches- no	Routine		DR	M F AP	

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imagin g type	Codes	Process
Radiographer 5 patient 1			Ankle-no		Routine	well *(they)* stood up and *(they)* was alright and *(they)* stood up and *(they)* just hobbled in so I thought *(they)* was alright	CR	M F LAT	Automatic

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 11 patient 1			Tib and fib-no		Routine	observing the fact that *(they)* had walked around from accident and emergency and that *(they)* walked into the room sort of unaided and *(they)* was, *(they)* was well and ok	CR	M P F AP	
Radiographer 11 patient 2			Hand and finger-no		Routine		CR		Thought through projections but not examination
Radiographer 11 patient 3			Hand and wrist-no		Routine		CR		
Radiographer 11 patient 4			Ankle-no		Routine		CR		Automatic
Radiographer 11 patient 5			Thumb-no		Routine		CR		
Radiographer 11 patient 6			Hip, Foot and ankle-yes	Trolley -yes	Complex		CR then DR		Thought through

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 12 patient 1			Ankle-no		Routine	like the patient obviously I just did was completely fine and walking in and everything	CR	M P F AP	Automatic

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 14 patient 1	yes		Wrist, forearm, elbow in sling-yes	DR	Complex			SO M I AP	Thought through examination order

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 15 patient 1			Ankle-no		Routine		CR	P M C F AP	
Radiographer 15 patient 2			Wrist/scaphoid	On trolley but able to get off-no	Routine	I found out the reason why *(they)* is on the trolley, its ,I could easily do on the table, but it er, the table would go, just *(they)* was helpful and confident that *(they)* can	CR	M SOD F AP	
Radiographer 15 patient 3			Ankle-no		Routine			M P F AP	

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 18 patient 1		Yes-confused behaviour	Ankle and calcaneum-no	Should have been on trolley-no	Intermediate	but *(they)* is like I prefer standing up	CR	M P I AP	Automatic
Radiographer 18 patient 2			Shoulder-yes		Intermediate		CR	P I AP	Automatic
Radiographer 18 patient 3		Yes-Needs interpreter	Knee-no	Chair-yes	Complex	Because the person that *(they)* was with was saying that *(they)* is unstable and if they are querying a fracture of the knee which is what it says in the clinical information and *(they)* is unsteady on *(their)* feet anyway,	CR	L C M P F AP	
Radiographer 18 patient 4	Yes		Forearm, elbow and wrist-no		Intermediate		DR	M I AP	Thought through order of exam
Radiographer 18 patient 5		Yes-Needs interpreter	Knee in plaster-yes	Trolley-yes	Complex		CR	L P I AP	

Patient case	Child	Compliance	Complex	Bed/Trolley/	Complexity	Complexity mentioned by	Imaging	Codes	Process

		capacity concern	body part	chair		radiographer in interview	type		
Radiographer 19 patient 1			Foot-no		Routine	because it was run of the mill	DR	SOD I AP	Automatic
Radiographer 19 patient 2			Foot-no		Routine		CR	SOD M F AP	Automatic
Radiographer 19 patient 3			Foot and ankle-no	Chair-yes	Intermediate		DR	SOD P M I AP	Automatic
Radiographer 19 patient 4	Yes		Ankle-no		Intermediate	I think sometimes you are just literally on autopilot because you do it so often	DR	P M I AP	Automatic

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process

Radiographer 20 patient 1			Hand-no		Routine		CR	M F	
Radiographer 20 patient 2			Foot and ankle-no		Routine		CR	M F AP	
Radiographer 20 patient 3	Yes		Index finger-no		Intermediate		DR	SOD M I AP	
Radiographer 20 patient 4			Hand-no		Routine		CR	SOD M F AP	
Radiographer 20 patient 5			Foot-no		Routine		CR	M P C F AP	
Radiographer 20 patient 6			Humerus-no	Zimmer frame-yes	Intermediate	yeah I just said you can keep your weight on the zimmer on the opposite side not the affected side if you wish and *(they)* was happy to do that	CR	M C F AP	
Radiographer 20 patient 7			Forearm-no		Routine		CR	M F	

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 21 patient 1			Elbow in sling-yes		Intermediate	I stopped *(them)* and I said to *(them)* we can work around your injury and I can do the examination in a different way	CR	M P I LAT	
Radiographer 21 patient 2		Confused-yes	Pelvis and hip-yes	Trolley-yes	Complex	Yes very complex	CR	M SO I AP	
Radiographer 21 patient 3			Foot		Routine	because the patient was very co-operative so *(they)* actually placed the foot on the cassette as was asked of *(them)* with no need for help or any further explanations and on the oblique	CR	SOD F	Automatic
Radiographer 21 patient 4			Ankle, foot, toe		Routine Rad thinks it was Intermediate	the patient seemed to have difficulty grasping erm what was being explained to *(them)*	CR	M SOD F	

Radiographer 21 patient 5			Shoulder-yes		Complex Rad thinks it was Intermediate			SO M I AP	

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 24 patient 1		Yes-confused	Ankle in splint-yes	Trolley-yes	Complex	*(they)* didn't seem to have a problem with pain but the main worry was sort of like exacerbating the erm the injury	CR	SO C I AP	
Radiographer 24 patient 2	Yes		Hand and thumb-no		Intermediate		DR	SOD M I AP	Automatic
Radiographer 24 patient 3			Ankle and lower leg-no	Chair-yes	Intermediate			M P I AP	Automatic
Radiographer 24 patient 4			Foot-no	Chair-yes	Intermediate	I mean *(they)* had been, *(they)* was fully with it at the scene, knew *(they)* was so , I just left the sort of choices with *(them)* in	CR	SOD F AP	

						terms of positioning			
Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Process
Radiographer 26 patient 1		Yes- confused behaviour	Ankle, tib and fib in splint-yes	Trolley	Complex	erm so I pretty much decided not to move the patient at all because I didn't know what was going on and the doctors didn't really have a huge idea of what was going on yet so erm I didn't want to move the patient anything that I had to so I did most of the moving of the equipment rather than the patient	DR	L SO P I AP	Thought through

Appendix 2b: Table 2 (routine), 3 (intermediate) and 4 (complex)

Table 2 Tabulation of routine cases

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Processing
Radiographer 1 patient 3			Hand -no		Routine	Calls it standard	DR		Automatic
Radiographer 1 patient 7			Finger-no		Routine		CR	SOD AP	Automatic
Radiographer 1 patient 13			Finger-no		Routine	I made the judgement call that I could with, in in safety move the finger to gain optimal positioning		M F	Automatic
Radiographer 1 patient 14			Wrist-no		Routine	I believe the patient was able erm to perform a lateral		M C I	Automatic
Radiographer 2 patient 1			Ankle and foot -no		Routine		CR	SOD M F	Automatic
Radiographer 2 patient 2			Hand and wrist-no		Routine		CR	M P I SO	Automatic
Radiographer 2 patient 5			Foot and elbow		Routine *Turned out	I didn't want to disturb anything that was already going on and I did ask the	DR	SO P M F	Thought through

					to be intermediate	patient if *(they)* could straighten *(their)* elbow, when *(they)* said 'no' that is when I decided to adapted technique			
Radiographer 3 patient 2			Hand -no		Routine		CR	SOD M F AP	Automatic
Radiographer 3 patient 3			Finger-no		Routine		CR	SOD M F AP	Automatic
Radiographer 3 patient 4			Tib and fib-no		Routine	that *(they)* could move about on crutches and they were obviously happy for *(them)* to be on crutches so *(they)* could weight bear a bit	CR	M F AP	
Radiographer 4 patient 1			Knee- no	On crutches-no	Routine		DR	M F AP	
Radiographer 5 patient 1			Ankle-no		Routine		CR	M F LAT	Automatic
Radiographer11 patient 1			Tib and fib-no		Routine		CR	M P F AP	
Radiographer 11 patient 2			Hand and finger-no		Routine		CR	SOD M F	Thought through projections but not examination
Radiographer 11			Hand and		Routine		CR	SOD M F	

patient 3			wrist-no					AP	
Radiographer 11 patient 4			Ankle-no		Routine		CR	M F AP	Automatic
Radiographer 11 patient 5			Thumb-no		Routine		CR	SOD M LAT	
Radiographer 12 patient 1			Ankle-no		Routine	like the patient obviously I just did was completely fine and walking in and everything	CR	M P F AP	Automatic
Radiographer 15 patient 1			Ankle-no		Routine		CR	P M C F AP	
Radiographer 15 patient 2			Wrist/scaphoid	On trolley but able to get off-no	Routine	I found out the reason why *(they)* is on the trolley, its ,I could easily do on the table, but it er, the table would go, just *(they)* was helpful and confident that *(they)* can	CR	M SOD F AP	
Radiographer 15 patient 3			Ankle-no		Routine			M P F AP	
Radiographer 19 patient 1			Foot-no		Routine	because it was run of the mill	DR	SOD I AP	Automatic
Radiographer 19 patient 2			Foot-no		Routine		CR	SOD M F AP	Automatic

Radiographer20 patient 1			Hand-no		Routine		CR	M F	
Radiographer 20 patient 2			Foot and ankle-no		Routine		CR	M F AP	
Radiographer 20 patient 4			Hand-no		Routine		CR	SOD M F AP	
Radiographer 20 patient 5			Foot-no		Routine		CR	M P C F AP	
Radiographer 20 patient 7			Forearm-no		Routine		CR	M F	
Radiographer 21 patient 3			Foot		Routine	because the patient was very co-operative so *(they)* actually placed the foot on the cassette as was asked of *(them)* with no need for help or any further explanations and on the oblique	CR	SOD F	Automatic
Radiographer 21 patient 4			Ankle, foot, toe		Routine- Rad thinks it was Intermediate	the patient seemed to have difficulty grasping erm what was being explained to *(them)*	CR	M SOD F	
Radiographer23 patient 1			Ankle and toe-no		Routine		CR	P F AP	

Table 3 Tabulation of intermediate cases

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Processing
Radiographer 1 patient 2	Yes		Knee-no		Intermediate		CR	M C P	Automatic
Radiographer 1 patient 4	Yes		Toe-no		Intermediate	Would have brought mother in if had any concerns		P	
Radiographer 1 patient 6			Shoulder-yes		Intermediate	I believed that *(they)* actually could do the examination	CR	M SOD C AP	Thought through
Radiographer 1 patient 9	Yes		Ankle-no		Intermediate	I made a decision that the child was capable and competent and erm to come into the room by herself so I suppose I made that decision but apart from that it was a quite routine	CR	M F AP	Automatic
Radiographer 1 patient 10			Shoulder and forearm-yes		Intermediate	because it was such a vague request they have asked to image quite allot of the upper arm and so what I was trying to	DR	M SOD C I AP	

						assess with that point as to if there was a particular focal point ....of pain			
Radiographer 1 patient 12	Yes		Wrist - no		Intermediate	potentially it could be a more challenging examination because it could be more painful for *(them)* to move *(their)* arm/wrist	DR	M SO I AP	Thought through
Radiographer 2 patient 3	Yes		Wrist in sling-no		Intermediate *Rad says routine	there was no requirement for any adapted technique, the patient was quite fit, erm *(they)* understood what I was saying to *(them)*	DR	M SO SOD I	Automatic
Radiographer 3 patient 1			Ankle in splint-no	Trolley-yes	Intermediate		CR	L P F AP	
Radiographer 18 patient 1		Yes-confused behaviour	Ankle and calcaneum-no	Should have been on trolley-no	Intermediate	but *(they)* is like I prefer standing up	CR	M P I AP	Automatic
Radiographer 18 patient 2			Shoulder-yes		Intermediate		CR	P I AP	Automatic

Radiographer 18 patient 4	Yes		Forearm, elbow and wrist-no		Intermediate		DR	M I AP	Thought through order of exam
Radiographer 19 patient 3			Foot and ankle-no	Chair-yes	Intermediate		DR	SOD P M I AP	Automatic
Radiographer 19 patient 4	Yes		Ankle-no		Intermediate	I think sometimes you are just literally on autopilot because you do it so often	DR	P M I AP	Automatic
Radiographer 20 patient 3	Yes		Index finger-no		Intermediate		DR	SOD M I AP	
Radiographer 20 patient 6			Humerus-no	Zimmer frame-yes	Intermediate	yeah I just said you can keep your weight on the zimmer on the opposite side not the affected side if you wish and *(they)* was happy to do that	CR	M C F AP	
Radiographer 21 patient 1			Elbow in sling-yes		Intermediate	I stopped *(them)* and I said to *(them)* we can work around your injury and I can do the examination in a different way	CR	M P I LAT	
Radiographer 24 patient 2	yes		Hand and thumb-no		Routine		DR	SOD M I AP	Automatic

Radiographer 24 patient 3			Ankle and lower leg-no	Chair-yes	Intermediate			M P I AP	Automatic
Radiographer 24 patient 4			Foot-no	Chair-yes	Intermediate	I mean *(they)* had been, *(they)* was fully with it at the scene, knew *(they)* was so , I just left the sort of choices with *(them)* in terms of positioning	CR	SOD F AP	

Table 4 Tabulation of complex cases

Patient case	Child	Compliance capacity concern	Complex body part	Bed/Trolley/ chair	Complexity	Complexity mentioned by radiographer in interview	Imaging type	Codes	Processing
Radiographer 1 patient 1		Yes-dementia	Hand-no	Yes-bed	Complex		CR	P M AP	Some elements automatic/ thought through
Radiographer 1 patient 5	Yes	Yes-very young	Tib and Fib-no		Complex	I did take into account the fact that the child was erm slightly upset erm the age of the child as well	DR	M SO	Thought through
Radiographer 1 patient 8			Shoulder-yes	Yes-trolley	Complex	**that was a more complicated examination** Yeah yeah I know	CR	P C F AP L	Automatic but didn't work acknowledges it should have been thought through
Radiographer 1 patient 11			Knee in splint-yes	Yes-bed	Complex	I wasn't going to risk any type of injury to *(them)*when *(their)* when *(they)* was in a fragile, in a fragile state	CR	SO P F AP	
Radiographer 2 patient 4		Yes-compliance	Elbow-yes	Trolley-yes	Complex	I didn't know how much the patient could move the arm and I really didn't realise *(they)* would be in		M F L	Thought through

						kind of a stupor			
Radiographer 11 patient 6			Hip, Foot and ankle-yes	Trolley -yes	Complex		CR then DR	SO C L P I AP	Thought through
Radiographer 14 patient 1	yes		Wrist, forearm, elbow in sling-yes		Complex		DR	SO M I AP	Thought through examination order
Radiographer 18 patient 3		Yes-Needs interpreter	Knee-no	Chair-yes	Complex	Because the person that *(they)* was with was saying that *(they)* is unstable and if they are querying a fracture of the knee which is what it says in the clinical information and *(they)* is unsteady on *(their)* feet anyway,	CR	L C M P F AP	
Radiographer 18 patient 5		Yes-Needs interpreter	Knee in plaster-yes	Trolley-yes	Complex		CR	L P I AP	
Radiographer 21 patient 2		Confused-yes	Pelvis and hip-yes	Trolley-yes	Complex	Yes very complex	CR	M SO I AP	
Radiographer			Shoulder-		Complex			SO M I	

21 patient 5			yes		Rad thinks it was intermediate			AP	
Radiographer 24 patient 1		Yes-confused	Ankle in splint-yes	Trolley-yes	Complex	*(they)* didn't seem to have a problem with pain but the main worry was sort of like exacerbating the erm the injury	CR	SO C I AP	

Radiographer 26 patient 1		Yes-confused behaviour	Ankle, tib and fib in splint-yes	Trolley	Complex	erm so I pretty much decided not to move the patient at all because I didn't know what was going on and the doctors didn't really have a huge idea of what was going on yet so erm I didn't want to move the patient anything that I had to so I did most of the moving of the equipment rather than the patient	DR	L SO P I AP	Thought through

Appendix 2c: Table 6 – table of distribution of codes in relation to complexity

Routine cases										
Study number	M	SO	SOD	L	C	P	I	F	AP	LAT
R 1 P 3										
R 1 P 7			X						X	
R 1 P 13	X							X		
R 1 P 14	X				X		X			
R 2 P 1	X		X					X		
R 2 P 2	X					X	X			
R 2 P 5	X	X				X		X		
R 3 P 2	X		X					X	X	
R 3 P 3	X		X					X	X	
R 3 P 4	X							X	X	
R 4 P 1	X							X	X	
R 5 P 1	X							X		X
R 11 P 1	X					X		X	X	
R 11 P 2	X		X					X		
R 11 P 3	X		X					X	X	
R 11 P 4	X							X	X	
R 11 P 5	X		X							X
R 12 P 1	X					X		X	X	
R 15 P 1	X				X	X		X	X	
R 15 P 2	X		X					X	X	
R 15 P 3	X					X		X	X	
R 19 P 1			X				X		X	
R 19 P 2	X		X					X	X	
R 20 P 1	X							X		
R 20 P 2	X							X	X	
R 20 P 4	X		X					X	X	
R 20 P 5	X				X	X		X	X	

R 20 P 7	X							X		
R 21 P 3			X					X		
R 21 P 4	X		X					X		
S 23 P 1						X		X	X	
R 24 P 2	X		X				X		X	
	27/30	1/30	14/30	0/32	3/32	8/32	4/29	25/29	19/21	2/21
R	90%	3.3%	46.7%	0%	9.4%	25%	13.8%	86.2%	90.5%	9.5%

Intermediate cases										
Study number	M	SO	SOD	L	C	P	I	F	AP	LAT
R 1 P 2	X				X	X				
R 1 P 4						X				
R 1 P 6	X		X		X				X	
R 1 P 9	X							X	X	
R 1 P 10	X		X		X		X		X	
R 1 P 12	X	X					X		X	
R 2 P 3	X		X				X			
R 3 P 1				X		X		X	X	
R 18 P 1	X					X	X		X	
R 18 P 2						X	X		X	
R 18 P 4	X						X		X	
R 19 P 3	X		X			X	X		X	
R 19 P 4	X					X	X		X	
R 20 P 3	X		X				X		X	
R 20 P 6	X				X			X	X	
R 21 P 1	X					X	X			X
R 24 P 3	X					X	X		X	
R 24 P 4			X					X	X	
	14/16	1/16	6/16	1/16	4/18	9/18	11/15	4/15	14/15	1/15
	87.5%	6.3%	37.5%	6.3%	22.2%	50%	73.3%	26.7%	93.3%	6.7%

Complex cases										
Study number	M	SO	SOD	L	C	P	I	F	AP	LAT
R 1 P 1	X					X			X	
R 1 P 5	X	X								
R 1 P 8				X	X	X		X	X	
R 1 P 11		X				X		X	X	
R 2 P 4				X				X		
R 11 P 6		X		X	X	X	X		X	
R 14 P 1	X	X					X		X	
R 18 P 3	X			X	X	X		X	X	
R 18 P 5				X		X	X		X	
R 21 P 2	X	X					X		X	
R 21 P 5	X	X					X		X	
R 24 P 1		X			X		X		X	
R 26 P 1		X		X		X	X		X	
	7/12	8/12	0/12	4/12	4/13	7/13	7/11	4/11	11/11	0/11
	58.3%	66.7%	0%	33.3%	30.8%	53.8%	63.6%	36.4%	100%	0%

Appendix 2d: Radiographer 21 patient 1 transcription

Radiographer 21 patient 1 transcription

Q. You have been telling me all the way along what you have been doing and why you have been doing it so I just want to re-cap to make sure that I have got what you said.

A. right

Q. So you said when you brought the patient into the room, this was a really complex case wasn't it because the patient didn't speak English,

A. sighs

Q. erm when you brought the patient into the room you asked about the mechanism of injury because that helped inform you about how much you were going to be able to move the patient

A. and how much they can do for me, the co-operation from them, how much they can do

Q. and how much they can co-operate , erm and then you did your first image and you said that you positioned *(them)* **in the lateral position because that's how** *(they)* **presented in the sling so it was obvious that** *(they)* **could be reasonably comfortable in that position**

A. yes, yes

Q. and then the next thing that you did was that you reviewed the image and you said you did that because of how uncomfortable the patient was and that you wanted to

A. it was going to determine how I do the second view as in like a horizontal beam lateral or an AP or straight AP

Q. ok so it was going to inform you about how much range of movement I guess that the patient had

A. yes yes

Q.

A. That sounds exactly

Q. Well no no your explanation is better than mine

A. That's exactly the reason why, the range of movement

Q. Yes

A. That's exactly the reason why

Q. Ok and so we reviewed the image and you decided that there was a fracture and so when you went to speak to the patient rather than just assume *(they)* **could go into the position that you wanted, you asked, you demonstrated really and asked if** *(they)* **was able to do that,**

A. To do that - yes

Q. and *(they)* **said** *(they)* **couldn't really** *(they)***,** *(they)* **had a bit of a go didn't** *(they)*

A. yes *(they)* did yeah but *(they)* started screaming, screaming in pain

Q. yes *(they)* **did** *(they)* **started to complain of the pain, so you left** *(them)* **as** *(they)* **was**

A. but I stopped *(them)* and I said to *(them)* we can work around your injury and I can do the examination in a different way, I can approach the examination in a different way

Q. ok. erm What told you, that you could do it in a different way, how did you know you could?

A. Erm it's because erm the important thing was when I sat *(them)* down there in my mind I already, I already have assessed that when I walk into the room I have sat *(them)* in a proper way where I am able to do the horizontal beam for example if I was going to bring somebody into this room there is no point this tube won't go on that side to even try and, so you have to make sure then the patient is sitting in the right way

Q. Ok so before you even brought *(them)* **in the room**

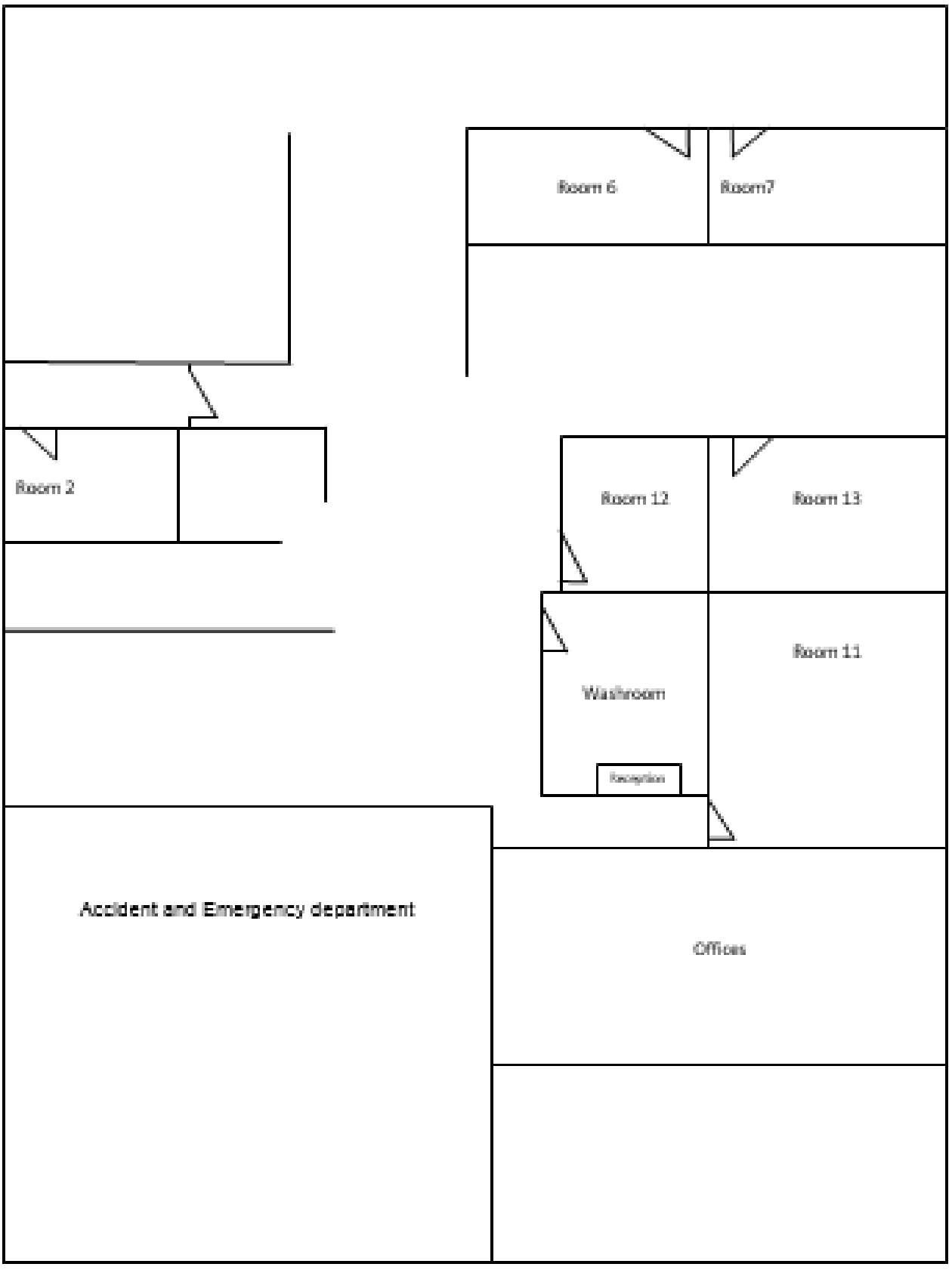
A. I was thinking about that

Q. You premeditated where to put *(them)* **in case you had to do an adapted technique**

A. Yes

Ok thank you

Appendix 2e: Site 2 map



Appendix 2f: Table 7 behaviour of each radiographer

study number	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine										
R 1 P 3										
R 1 P 7			X						X	
R 1 P 13	X							X		
R 1 P 14	X				X		X			
Intermediate										
R 1 P 2	X				X	X				
R 1 P 4						X				
R 1 P 6	X		X		X				X	
R 1 P 9	X							X	X	
R 1 P 10	X		X		X		X		X	
R 1 P 12	X	X					X		X	
Complex										
R 1 P 1	X					X			X	
R 1 P 5	X	X								
R 1 P 8				X	X	X		X	X	
R 1 P 11		X				X		X	X	
	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine										
R 2 P 1	X		X					X		
R 2 P 2	X	X				X	X			
R 2 P 5	X	X				X		X		
Intermediate										
R 2 P 3	X		X				X			
Complex										

R 2 P 4	X							X		
	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine										
R 3 P 2	X		X					X	X	
R 3 P 3	X		X					X	X	
R 3 P 4	X							X	X	
Intermediate										
R 3 P 1				X		X		X	X	
	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine										
R 11 P 1	X					X		X	X	
R 11 P 2	X		X					X		
R 11 P 3	X		X					X	X	
R 11 P 4	X							X	X	
R 11 P 5	X		X							X
Complex										
R 11 P 6		X		X	X	X	X		X	
	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine	X									
R 15 P 1	X				X	X		X	X	
R 15 P 2	X		X					X	X	
R 15 P 3	X					X		X	X	
	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine										
R 19 P 1			X				X		X	
R 19 P 2	X		X					X	X	
Intermediate										
R 19 P 3	X		X			X	X		X	
R 19 P 4	X					X	X		X	

	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine										
R 20 P 1	X							X		

R 20 P 2	X							X	X	
R 20 P 4	X		X					X	X	
R 20 P 5	X				X	X		X	X	
R 20 P 7	X							X		
Intermediate										
R 20 P 3	X		X				X		X	
R 20 P 6	X				X			X	X	
	M	SO	SOD	L	C	P	I	F	AP	LAT
Routine										
R 21 P 3			X					X		
R 21 P 4	X		X					X		
Intermediate										
R 21 P 1	X					X	X			X
Complex										
R 21 P 2	X	X					X		X	
R 21 P 5	X	X					X		X	
	M	SO	SOD	L	C	P	I	F	AP	LAT
Intermediate										
R 24 P 2	X		X				X		X	
R 24 P 3	X					X	X		X	
R 24 P 4			X					X	X	
Complex										
R 24 P 1		X			X		X		X	