A Research-informed Teaching Model for Undergraduate Learning and Research Skills Development Using Collaborative Enquiry Based Learning

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Acknowledgements

The opportunity to complete this thesis has been very rewarding in that it has broadened my knowledge and development in this subject, introduced new methods and techniques, and led to a series of journal publications and conference presentations.

I would like to thank my supervisors Dr Leslie Robinson and Prof Peter Hogg for their academic and pastoral support. They have been a constant source of guidance and their feedback has been invaluable. The opportunity to undertake and complete this thesis has been tremendously rewarding as it has broadened my outlook on this subject, introduced me to new ideas and concepts, and most importantly has led to a series of journal publications related to my work.

I am also grateful for the support and encouragement from my family and my wife Nadine. Finally, I would like to thank all the undergraduate students, academic staff and clinical placement educators who acted as participants for my research.

Declaration of published work

The publications submitted are based on the candidate's own independent work. The candidate has undertaken the research published with guidance from supervisors / co-authors during this process. The candidate has made substantial contributions to the acquisition, analysis, interpretation of data for the work; drafted the work; revising them critically for intellectual content following feedback from supervisors/co-authors and journal reviewers.

The candidate is corresponding author for all submitted work, with the exception of '*An observational study of cross-cultural communication in short-term, diverse professional learning groups'* (**Appendix 1**), where the candidate gained experience as a co-author in a paper related to the candidate's area of research. As corresponding author, the candidate has taken primary responsibility for communication with the journal during the manuscript submission, peer review, and publication process.

For ease of distinguishing papers from other citations, throughout the thesis, papers included in the submission are cited in bold (e.g. **Paper 1**).

List of abbreviations and terms

AT	Academic Tutor
CEBL	Collaborative Enquiry-Based Learning
CPE	Clinical Placement Educator
CEBL	Collaborative Enquiry-Based Learning
CL	Collaborative Learning
EBL	Enquiry-Based Learning
FG	Focus Group
FHEQ	Framework for Higher Education Qualifications
HE	Higher Education
HEA	Higher Education Academy
HEI	Higher Education Institute
HEPI	Higher Education Policy Institute
HFFCE	Higher Education Funding Council for England[1]
NWKM	New World Kirkpatrick Model
PBL	Problem Based Learning
QAA	Quality Assurance Agency
REF	Research Excellence Framework
RiT	Research-informed Teaching
RiTe	Research-informed Teaching experience
TEF	Teaching Excellence Framework
TA	Thematic Analysis
UoS	University of Salford

[1] HEFCE closed at the end of March 2018. Many of HEFCE's functions will be continued by the Office for Students, the new regulator of higher education in England, and Research England, the new council within UK Research and Innovation

Glossary

This glossary contains an explanation of terms associated with this thesis.

Collaborative learning
Collaborative learning is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings.

Enquiry-based learning
Enquiry-based learning is a form of active learning that starts by posing questions, problems or scenarios, rather than simply presenting established facts. The process is often assisted by a facilitator. Leaners will identify and research issues and questions to develop their own knowledge or solutions.

OPTIMAX
OPTIMAX is a multicultural 3-week residential research summer school. It was developed as a direct consequence of RiTe. The name itself is neither an acronym, abbreviation or initialism. It is a neologism and its etymology derived from the initial grant application where the grant administrator created this for the summer school event.

Research-informed Teaching
Research-informed Teaching (RiT) refers to the practice of linking research with teaching in Higher Education. RiT is used as an umbrella term to describe types of activities through which knowledge is produced, placing emphasis on developing skills of research and enquiry to enhance student learning.

Research-informed Teaching experience
The Research-informed Teaching experience (RiTe) combines RiT with collaborative enquiry based-learning within the BSc (Hons) Diagnostic Radiography curriculum at the University of Salford. RiTe is a novel approach to student learning on the curriculum by facilitating the understanding of key radiographic concepts to span the gap between academic knowledge and clinical practice as well as developing student research skills from year 1 (level 4) onwards.

Abstract

Student-centred approaches to Research-informed teaching (RiT) have been shown to provide students with stimulating learning experiences, thereby enhancing student learning. The Research-informed Teaching experience (RiTe) was introduced into the undergraduate Diagnostic Radiography curriculum at the University of Salford in 2009 as a RiT model to support student learning and develop research skills using collaborative enquiry-based learning (CEBL). The publications in this thesis present a range of evaluations and educational research in the context of two student-centred RiT activities: i) RiTe and ii) OPTIMAX.

Mixed methods research was used to explore the student learning experience of RiTe and OPTIMAX within a single Higher Education Institute along with the perceptions of RiTe by academic tutors and clinical placement educators. The theoretical framework for the publications in this thesis posteriori is the New World Kirkpatrick Model which provides a holistic interpretation and conceptualisation of the publications.

Analysis of student responses found that both RiTe and OPTIMAX were valued and enjoyable learning activities. This supports the importance of student evaluation and how learning activities that are positively received by students are an important proxy for learning. Results also indicated the co-production of knowledge and cross-proliferation of experiences via CEBL a key element of both activities. However, it was identified that students felt that they could not share knowledge with qualified practitioners following RiTe. Academic tutor and clinical placement educator research agreed that RiTe helped students to link theory with practice and developed their research skills. They also felt RiTe supported the development of key employability skills, including communication and team working.

Models such as RiTe and OPTIMAX could be used to support student learning and embed research skills development. The development of a psychometric scale is currently being undertaken to further evaluate student self-efficacy and task value following RiTe. Further research is also needed to better understand whether research activity is continued beyond registration and first post qualification following RiTe.

Appended publications

This PhD thesis is based on the following published work:

Paper	Authors	Title of paper	Journal details
1	Higgins, R., Hogg, P. & Robinson, L	Integrating Research-informed Teaching within an Undergraduate Level 4 (year 1) Diagnostic Radiography Curriculum: A Pilot Study	*Journal of Vocational Education & Training* (2013), **65**(3): 351-368. Citations: 5
2	Higgins, R., Hogg, P. & Robinson, L.	Towards a research informed teaching experience within a diagnostic radiography curriculum: The level 4 (year 1) student holistic experience	*Radiography* (2013), **19**(1): 62-66. Citations: 9
3	Higgins, R., Robinson, L. & Hogg P.	An evaluation of the student and tutor experience of a residential summer school event (OPTIMAX)	*Radiography* (2014), **20**(4): 363-368. Citations: 3
4	Higgins, R., Robinson, L. & Hogg, P.	Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: Results from a level 4 (year 1) student cohort	*Radiography* (2014), **20**(2): 100-106. Citations: 9
5	Higgins, R., Hogg, P. & Robinson, L	Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: A reflection	*Radiography* (2017), **23**: S30-36. Citations: 2
6	Higgins, R., Hogg, P. & Robinson, L	Research Informed Teaching Experience in Diagnostic Radiography: Perspectives of Academic Tutors and Clinical Placement Educators	*Journal of Medical Imaging and Radiation Sciences* (2017), **48**(23): 226-232. Citations: 1

My contributions to these publications are as follows:

Paper	Authors	Detail of Independent contribution	Detail of joint contribution
1	Higgins, R., Hogg, P. & Robinson, L	Conceived research undertook focus group and questionnaire. Interpreted data and conducted thematic analysis.	Principal/main author of the paper. Wrote the paper in with my co-authors.
2	Higgins, R., Hogg, P. & Robinson, L.	Conceived research, undertook focus group and interpreted qualitative data and conducted thematic analysis.	Principal/main author of the paper. Wrote the paper with my co-authors.
3	Higgins, R., Robinson, L. & Hogg P.	Conceived research, undertook focus group and interpreted qualitative data and conducted thematic analysis.	Principal/main author of the paper. Wrote the paper with my co-authors.
4	Higgins, R., Robinson, L. & Hogg P.	Conceived research, developed, tested and modified the online questionnaire. Analysed and interpreted data.	Principal/main author of the paper. Wrote the paper with my co-authors.
5	Higgins, R., Hogg, P. & Robinson, L	Conceived research, developed, tested and modified the online questionnaire. Analysed and interpreted data.	Principal/main author of the paper. Wrote the paper with my co-authors.
6	Higgins, R., Hogg, P. & Robinson, L	Conceived research, developed, tested and modified the online focus group. Analysed and interpreted data.	Principal/main author of the paper. Wrote the paper with my co-authors.

Summary of published work

Paper 1:

Higgins, R., Hogg, P. & Robinson, L. (2013). Integrating Research-informed Teaching within an Undergraduate Level 4 (year 1) Diagnostic Radiography Curriculum: A Pilot Study. *Journal of Vocational Education & Training*, **65**(3): 351-368.

This article discusses the piloting and evaluation of the Research-informed Teaching experience (RiTe) project. The aim of RiTe was to link teaching and learning with research within an undergraduate diagnostic radiography curriculum. A preliminary pilot study of RiTe was undertaken with a group of level 4 (year 1) volunteer BSc (Hons) diagnostic radiography students to evaluate their experiences. The students undertook a week-long set of activities to facilitate their understanding of the effects of X-ray exposure factor settings on image quality and patient radiation dose. A mixed methods approach using a group interview with the students in conjunction with a student evaluation form was used to assess their experiences. Analysis of both sets of data revealed a positive student learning experience, although the student perception of the purpose of RiTe needed to be more explicit. RiTe has now become integrated into the level 4 curriculum. Further work is planned to better examine the student holistic experience of RiTe.

Scope and aims of journal: The Journal of Vocational Education & Training has interest in the study of curriculum, pedagogy, and assessment, as well as economic, cultural and political aspects related to the role of vocational and professional education and training in society.

Paper 2:

Higgins, R., Hogg, P. & Robinson, L. (2013). Towards a research informed teaching experience within a diagnostic radiography curriculum: The level 4 (year 1) student holistic experience. *Radiography*, **19**(1): 62-66.

Aim: This article discusses the level 4 (year 1) diagnostic radiography student holistic experience of the Research-informed Teaching experience (RiTe) at the University of Salford, UK. The purpose of RiTe is to expose undergraduate radiography students to more formal research, as part of their normal teaching and learning experience.

Method: A grounded theory approach was adopted and a focus group with eight level 4 students was used to explore and evaluate the student experience and perception of RiTe.

Results: Open coding defined categories and sub-categories, with axial and selective coding used to interrogate and explore the relationships between the focus group data. A number of insights were gained into the student holistic experience of RiTe. The issue of leadership for level 4 students was also identified.

Discussion: The focus group participants found RiTe to be an extremely positive learning experience. RiTe also facilitated their translation of learnt theory into clinical skills knowledge alongside their understanding of and desire to participate in more research as undergraduates. The article also highlights areas for future research.

Scope and aims of journal: The journal of Radiography promotes evidence-based practice by disseminating high quality clinical, scientific and educational research related to all aspects of diagnostic and therapeutic radiography.

Paper 3:

Higgins, R., Robinson, L. and Hogg P. (2014). An evaluation of the student and tutor experience of a residential summer school event (OPTIMAX). *Radiography*, **20**(4): 363-368.

Aim: To explore the experiences of students and tutors who participated in a residential multi-cultural and multi-professional 3-week summer school event (OPTIMAX).

Method: A grounded theory approach was adopted. Two semi-structured focus group interviews (student and tutor) were conducted to explore participant experiences. Both focus groups were audio recorded and then transcribed and coded to identify the main themes and draw conclusions.

Results: Inductive coding defined categories and sub-categories to explore the relationships within and between the two sets of focus group data.

Discussion: OPTIMAX was seen a positive experience by both students and tutors and provided an opportunity to undertake team learning with peers from different countries or professional backgrounds. However, consideration needs to be given to team size and tutor leadership.

Summary: By participating with international collaborative projects such as this, there is an opportunity to develop learning and explore current practices within radiography.

Scope and aims of journal: The journal of Radiography promotes evidence-based practice by disseminating high quality clinical, scientific and educational research related to all aspects of diagnostic and therapeutic radiography.

Paper 4:

Higgins, R., Robinson, L. and Hogg P. (2014). Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: Results from a level 4 (year 1) student cohort. *Radiography*, **20**(2): 100-106.

Aim: Previously we reported on focus group research which explored the level 4 (year 1) student experience of the Research-informed Teaching experience (RiTe). This article discusses follow up research with a new student cohort.

Method: An online questionnaire was used to explore the level 4 student cohort experience of RiTe. A Multi-method approach was taken to analyse the data, identify themes and link questionnaire findings with those from the focus group research.

Results: A 54% (27/50) response rate was achieved. Students found RiTe to be a positive experience and there was strong agreement that it had increased their knowledge of research methods and understanding of key areas of practice.

Conclusions: Results from the questionnaire supported the focus group findings. One of the key factors in the success of RiTe was that of collaborative learning. This was achieved by the students undertaking an inquiry and situated approach to learning within small groups.

Scope and aims of journal: The journal of Radiography promotes evidence-based practice by disseminating high quality clinical, scientific and educational research related to all aspects of diagnostic and therapeutic radiography.

Paper 5:

Higgins, R., Hogg, P. & Robinson, L. (2017). Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: A reflection. *Journal of Radiography*, **23**:S30-S36.

Aim: To evaluate the learning experience of a level 5 (year 2) student cohort within a research-informed teaching (RiT) activity and to map findings against learning outcomes and level descriptors using constructive alignment.

Method: An online questionnaire was used to explore the level 5 student experience of a Research-informed Teaching (RiT) activity. Responses were retrospectively mapped against Framework for Higher Education Qualifications (FHEQ) level descriptors for level 5 using constructive alignment.

Results and Discussion: 31 out of 46 level 5 students completed the questionnaire (67% response rate). Analysis of the questionnaire supported the integration of this RiT activity within the curriculum in terms of learning and research skill development by students. However, it was identified that this activity could be revised further to better align with level 5 descriptors and incorporate additional higher-level cognitive processes.

Conclusion: Learning outcomes for this RiT activity were constructively aligned with FHEQ level 5 descriptors. Recommendations are provided on how these could be further refined to ensure students undertake a more critical approach to the application of theory into practice. Discussion also considers how this process could be used to develop a similar RiT activity at level 6 (year 3).

Scope and aims of journal: The journal of Radiography promotes evidence-based practice by disseminating high quality clinical, scientific and educational research related to all aspects of diagnostic and therapeutic radiography.

Paper 6:

Higgins, R., Hogg, P. & Robinson, L. (2017). Academic tutors and placement educators' perceptions of integrating research-informed teaching within an undergraduate diagnostic radiography curriculum. *Journal of Medical Imaging and Radiation Sciences,* **48**(3): 226-232.

Introduction: This small-scale qualitative research study investigated the perceptions of integrating research-informed teaching (RiT) within an undergraduate diagnostic radiography curriculum by both academic tutors and clinical placement educators**.**

Method: A stratified and purposive sampling approach was used to recruit participants and two asynchronous on-line focus groups (OFGs) were used to collect the data. An inductive thematic approach was taken to analyse both sets of OFG data**.**

Results and discussion: Five academic tutors (ATs) and 4 clinical placement educators (CPEs) participated with the research. Three overarching themes common to both sets of OFG data were identified. Findings confirmed that both OFGs felt that the Research-informed Teaching experience (RiTe) facilitated student development of research skills and understanding of the effects of exposure factor manipulation with regard to minimising radiation dose and optimising image quality (skill acquisition). However, clinical placement educators identified that students may find it difficult to transfer and apply this knowledge into practice (theory-practice gap) or demonstrated soft skills.

Conclusion: Greater involvement of placement educators may be needed to overcome issues with the translation of knowledge and skills acquired with RiTe into clinical placement (theory-practice gap and skill acquisition). It was also felt that RiTe could be developed for qualified staff, although there may difficulties in releasing staff from their clinical duties to attend**.**

Scope and aims of journal: The Journal of Medical Imaging and Radiation Sciences is committed to the dissemination of knowledge through the publication of scholarly research, primarily in the fields of radiation therapy, radiological technology, magnetic resonance imaging and nuclear medicine.

Supportive evidence

I have published several papers and one book chapter which are relevant to this thesis, as they provide additional information or perspectives to those in this thesis. These papers are presented below as supportive evidence:

Book chapter:

1. **Higgins, R**. (2018). 'Research-informed Teaching: Unlocking Student Research and Learning Potential' in van der Heiji-Meijer, A., Buissink, C & Hogg, P. *OPTIMAX 2018: A focus on education in radiology*. Hanze UAS: Groningen.

Papers:

1. **Higgins, R**., Owen, N. & Grant, L. (2016). 'Research- informed teaching'. *Imaging and Therapy Practice*, November 12-17.

2. **Higgins, R**., Robinson, L. & Hogg P. (2015). Invited Editorial: Unlocking Student Research Potential: Toward a Research Culture in Radiography Undergraduate Learning Curricular. *Journal of Medical Imaging and Radiation Sciences*, 46, Issue 3, Supplement, S6–S9.

3. **Higgins, R**., Robinson, L. & Hogg, P. (2013). Letter to the Editor: Re: RE: Attitude to and perceptions of research for health science lecturers. *Radiography*, **19**(4):369.

4. **Higgins, R**., Robinson, L. & Hogg, P. (2013). 'Developing undergraduate diagnostic student radiographers' research skills using research-informed-teaching. *Imaging and Therapy Practice*, May 27-29.

5. Norton, S. & Hogg, P., **Higgins, R**., Robinson, L., Norton, E., Mackay, S., Newton-Hughes, A., Szczepura, K. & Tootell, A., Farell, A., Manning, D. & Qaroot, B. A. (2012).'Enhancing the learning experience: RiTe II', *Imaging Therapy and Practice*, September 20-23.

6. **Higgins, R**., Hogg, P., Robinson, L. Newton-Hughes, A., Szczepura, K. & Tootell, A. (2011). 'The RiTe Project: Towards a research led informed teaching diagnostic radiography curriculum'. *Imaging Therapy and Practice (Synergy),* July 26-28.

Chapter One: Introduction and background

This thesis presents six publications that have explored and evaluated a Research-informed Teaching (RiT) model for undergraduate learning and research skills development using collaborative enquiry-based learning (CEBL) within a single Higher Education Institute (HEI). This model will be referred to as the Research-informed Teaching experience (RiTe) within the thesis.

Development of RiTe began in 2009 and integrates research and teaching within the Bachelor of Science Honours, BSc (Hons) Diagnostic Radiography curriculum at the University of Salford (UoS). RiTe was initiated to help create a greater understanding of research at undergraduate level and to facilitate undergraduate student understanding of key radiographic concepts using a student-centred RiT approach. Students learn about and undertake research relevant to their development as first post radiographers (dose optimisation and image quality) within CEBL groups. Following 3 years of iterative development and successful piloting, RiTe was fully introduced into the year 1 (level 4) undergraduate BSc (Hons) Diagnostic Radiography curriculum in 2012. Following further development, it was then introduced into the year 2 (level 5) curriculum in 2013.

Teaching approaches that are 'research-informed' are thought to be central to undergraduate and postgraduate learning within HEIs (McLinden *et al*., 2015). However, undergraduate education has historically been seen in conflict with the research agendas of academics (Lane, 1996; Sample, 1972). Nonetheless, the Boyer Commission report in the USA (Boyer, 1990) has helped to build a relationship between teaching and research by arguing that research and teaching should not be seen in opposition, but inextricably linked to one another (Cleaver *et al*., 2014; Willison & O'Regan, 2007; Brew, 2006). A key conclusion of the report was that research

should be the basis of all learning at university and that the production of knowledge should not be the exclusive activity of 'researchers', but rather one that all members of an institution can participate in. Furthermore, the report recommended that all undergraduates should engage in activities that include opportunities to learn through enquiry or research (Boyer, 1990; Cleaver *et al*., 2014).

There are many definitions and conceptualisations of what is meant by RiT, for example Hoddinott & Wuetherick (2005) described it as "*a continuum between teacher-focused research-based course content and a student focused research-based process of learning"* (p.32) and is explored further in Chapter 2. Nonetheless, undergraduate student engagement in research is often expressed as a high-impact learning experience, and an extensive array of literature exists on combining research with teaching and the associated benefits of this (e.g. Buckley *et al*., 2008; Stanford *et al.*, 2017). However, RiT is not only concerned with exposing students to research as part of their curriculum but can also play a wider role with the student development via key employability skills (Jenkins & Healey, 2009).

1.1 The Research-informed Teaching experience and OPTIMAX

Within radiography there is a need for research to underpin and inform clinical practice and for radiographers to have the skills and confidence with this (Gambling *et al*., 2003; Harris & Beardmore, 2009). The Society and College of Radiographers [SCoR] 'Research and the Radiography Profession: A Strategy for Research 2016 – 2021' (SCoR, 2015) also advocated the imbedding of research skills in the learning experience of every radiography student. According to Villa *et al.,* (2013) most University research activities usually involve students who are strong academically or are highly motivated to participate with research and this approach may exclude those students who might potentially benefit from this experience. RiTe

adopts an ‘equity cognitive’ approach, which extends research experience to all students from year 1 onwards regardless of academic ability or interest in research and culminates with a dissertation project in year 3 (Higgins *et al.*, 2015; Higgins *et al*., 2014a; Higgins *et al.,* 2013a, Higgins *et al.*, 2013b; Norton, *et al*., 2012).

RiTe takes a student-centred approach to teaching and is delivered over one-week. Students explore the relationship between image quality and X-radiation dose optimisation (linking theory with practice) working in CEBL groups. For year 2 students, RiTe has more task complexity using mathematical modelling for X-radiation dose calculations and a more robust method of measuring medical image quality. Each student works as a member of the CEBL group to achieve three common goals: (i) learning; (ii) problem-solving and (iii) developing research skills (Higgins *et al.*, 2013b; Higgins *et al*., 2011). A group presentation at the end of the week further develops group-working skills and allows students to demonstrate their communication and analytical skills. RiTe is commensurate with the Framework for Higher Education Qualifications of UK Degree-Awarding Bodies [FHEQ] level descriptors for year 1 and year 2 students set by the Quality Assurance Agency for Higher Education [QAA] (Higgins *et al*., 2017a).

Using RiT allows students to enhance their knowledge using critical thinking and research skills associated with their area of practice. However, the addition of CEBL with RiT helps to facilitate the sharing of this knowledge and learning experience with their peers (Bauer & Bennett, 2003; Al Qaroot & Sobuh, 2016). This links with the social constructivist theory of learning whereby knowledge is constructed via exploration and interaction with others (Vygotsky, 1978). Von Glaserfeld (1989) suggested that students construct their learning based on their experiences and learning activities that act as catalysts for their construction of meaning

within this social context help to align theory with practice. Collaborative learning activities are the essence of social constructivist learning and through working in groups using authentic contexts, students can refine and build upon their knowledge through shared meaning with their peers (Wood & O'Malley, 1995; Grabinger & Dunlap, 1995). It has also been suggested that CEBL has the potential to bridge the theory-practice gap by encouraging deeper exploration of a topic and increased research awareness (Horne *et al*., 2007). This is something that has also been identified with RiTe and is illustrated in Figure 1 by a group of year 2 students who were asked to reflect upon their experience of RiTe as part of a plenary session on what they had learnt or skills they had developed.

Figure 1: Reflection by one group of year 2 students about their experiences of RiTe. They were asked to consider what they had learnt or skills they had developed following their experience of RiTe.

RiTe has also led to the creation of a community where undergraduate Diagnostic Radiography students are co-producers of research with academics via the submission of journal papers or presentations at major conferences (Norton *et al*., 2012).

Following the experience gained from RiTe, OPTIMAX[2] was set up in 2013 and has run as a three-week international summer residential research school since. OPTIMAX built upon the experience gained from RiTe and brings together both undergraduate and postgraduate diagnostic radiography, nuclear medicine technology and physics students. Students are placed into diverse multi-cultural and multi-disciplinary CEBL groups and undertake research linked to X-radiation dose limitation whilst preserving medical image quality (**Paper 3**).

The introduction of learning activities that foster student-centred RiT within the undergraduate curriculum could lead to the creation of a high-quality student learning and research skills development environment. This in turn, could then generate students who are much more confident in undertaking research to generate evidence-based practice (EBP) within their own discipline (Gambling *et al*., 2003).

1.2 Research rationale

There are several reasons for this research based upon my personal motivations and the need to explore the student experience of learning within Higher Education (HE) (Tight, 2012). I have had many roles during my career but have always had an interest teaching and research. Following discussions with the Research Dean at the UoS in 2009, I was given the opportunity to work as part of a team to create a learning activity that would link theory with practice (dose optimisation and image quality) and develop student research skills. Following several iterations this learning activity was piloted and finally introduced into the year 1 Diagnostic Radiography curriculum at the UoS as RiTe in 2012. A direct consequence of RiTe was the development and introduction of OPTIMAX which was first held at the UoS in 2013 following

[2] OPTIMAX is neither an acronym, abbreviation or initialism. It is a neologism and its etymology derived from the initial grant application where the grant administrator created this for the summer school event.

a successful bid for European funding by the Research Dean and provided an opportunity to further explore this RiT model within a different context.

I did not set out to complete a PhD by Published Work but based on anecdotal feedback that students enjoyed RiTe and got a lot out of it as a learning activity I soon became interested in investigating the student experience of RiTe to find out why. This then led to series of publications exploring the student perspective of RiTe. I also investigated RiTe and OPTIMAX from the teacher perspective by gaining opinions from academic tutors (ATs) and clinical placement educators (CPEs) about these activities and whether they felt these supported student learning.

This PhD thesis is further justified by the lack of research on RiT within undergraduate Diagnostic Radiography courses and insufficient research information about CEBL when used with RiT. More importantly there is a growing acknowledgement that research competencies are valuable to students in terms of graduate employability and it is hoped that the publications in this thesis contribute further to discussion and debate about the teaching and learning of research methods (Kirton *et al.*, 2013).

1.3 The need to evaluate teaching and learning

The student's perspective of how they experience learning in HE is an important area of contemporary research into teaching and learning (Temple *et al*., 2014; Tight, 2012). Understanding and evaluating the undergraduate student experience of teaching and learning is essential in understanding the phenomena of student learning, development, motivation and engagement with learning activities such as RiTe and OPTIMAX (Krause & Coates, 2008; Brown *et al.*, 2002; Imafuku *et al.*, 2015). Student engagement is generally considered to be

among the better predictors of learning - the more students' study or practice a subject, the more they tend to learn about it (Carini *et al*., 2006). How students go about a task depends on what they want out of it and therefore their learning strategy is embedded in motive or reaction towards the task. If students do not value the task or do not expect success, they will likely adopt low level surface strategies that may suffice to pass exams or assignments but might not meet the requirements of the workplace (Biggs, 1991). Therefore, evaluation helps to identify whether learning activities are working in the ways intended or whether there are aspects that could be changed or improved (Aziz *et al*., 2018).

At one time or another, nearly all educators will need to evaluate an educational activity to determine its merit or worth (Cook, 2010). Therefore, evaluation forms an essential component in all aspects of teaching, learning and assessment to ensure students are provided with an effective learning experience (Houghton, 2016). According to Aston and Hallam (2014), evaluation is a term that represents the overarching value of the learning experience and how worthwhile learning has been. Evaluation differs from assessment in that it uses data to place value on an activity and seeks to describe and explain experiences of students and teachers to 'interpret' the effectiveness of the activity; whereas assessment focuses on student performance and success (Edwards in Wilkes & Bligh, 1999). Evaluation can also be used to follow students through their HE experiences from entry to exit and the transition from higher education to work (Tight, 2012). James and Roffe (2000) considered evaluation as the process of "*comparing the actual and real with the predicted or promised*" (p.12) which emphasises the need to reflect on what was achieved in comparison to what was hoped for.

1.4 Research focus of the publications

The focus of the research publications in this thesis is the exploration and evaluation of the student learning experience of RiTe to support undergraduate learning and research skills development at a one HEI (**Papers 1, 2, 4, 5**). Additionally, this thesis explores the participant experiences of a multi-cultural and multi-professional residential research summer school event (OPTIMAX) held at the same HEI in 2013 that builds upon the experiences and knowledge gained with RiTe (**Paper 3)**. Likewise, the AT and CPE perspectives of RiTe were explored (**Paper 6**) and provided information on whether they felt RiTe supported the development of students with both academic and key professional attributes. The core aims of my research were to:

- Explore the students' experiences and perceptions of RiTe as a learning activity;
- Explore the experiences and perceptions of OPTIMAX by students and academic tutors;
- Explore the clinical placement educators and academic tutor perceptions of RiTe.

1.5 Scope and significance of the publications

Many research educators view evaluation from the student perspective as an important factor in understanding student engagement and motivation with learning activities (Brown *et al*., 2002). Similarly, undergraduate student attitudes towards research are of importance given their influence upon motivation for development and research preparedness. This is an important consideration as students show greater persistence and motivation in academic tasks that they value and perceive to be relevant (Boswell, 2013).

The publications in this thesis include mixed methods research via small focus group (FG) interviews and attitudinal questionnaires with year 1 and 2 Diagnostic Radiography student cohorts at one HEI who undertook RiTe. They are not are not focused on learning outcomes and demonstration of knowledge (although this is explored in **Paper 5**), but rather the student experience as a proxy for learning. The AT and CPE perspective of RiTe was also investigated as this provided data on whether there was a mismatch between the student and teacher perception of RiTe and the development of academic and professional attributes (e.g. employability skills, research skills development and linking theory to practice). The student and AT perspective of OPTIMAX (**Paper 3**) was also explored using FG interviews.

An additional supplementary co-authored paper is also included as part of this thesis which explored cross-cultural communication and diverse learning within OPTIMAX. This helped as part of my PhD development with qualitative research by understanding the application of observational research of group interactions and the analysis of this using the Rapport Management framework (Appendix 1). A currently un-published research paper that builds upon the work in my thesis is also included (Appendix 2). This paper describes further work developing and validating a psychometric scale to explore both task value and self-efficacy following student participation with RiTe. Self-efficacy research is well established in the educational sector and theory tells us that if a student does not have a strong belief in themselves, then they may not be able to apply learning adequately (Bandura, 1997).

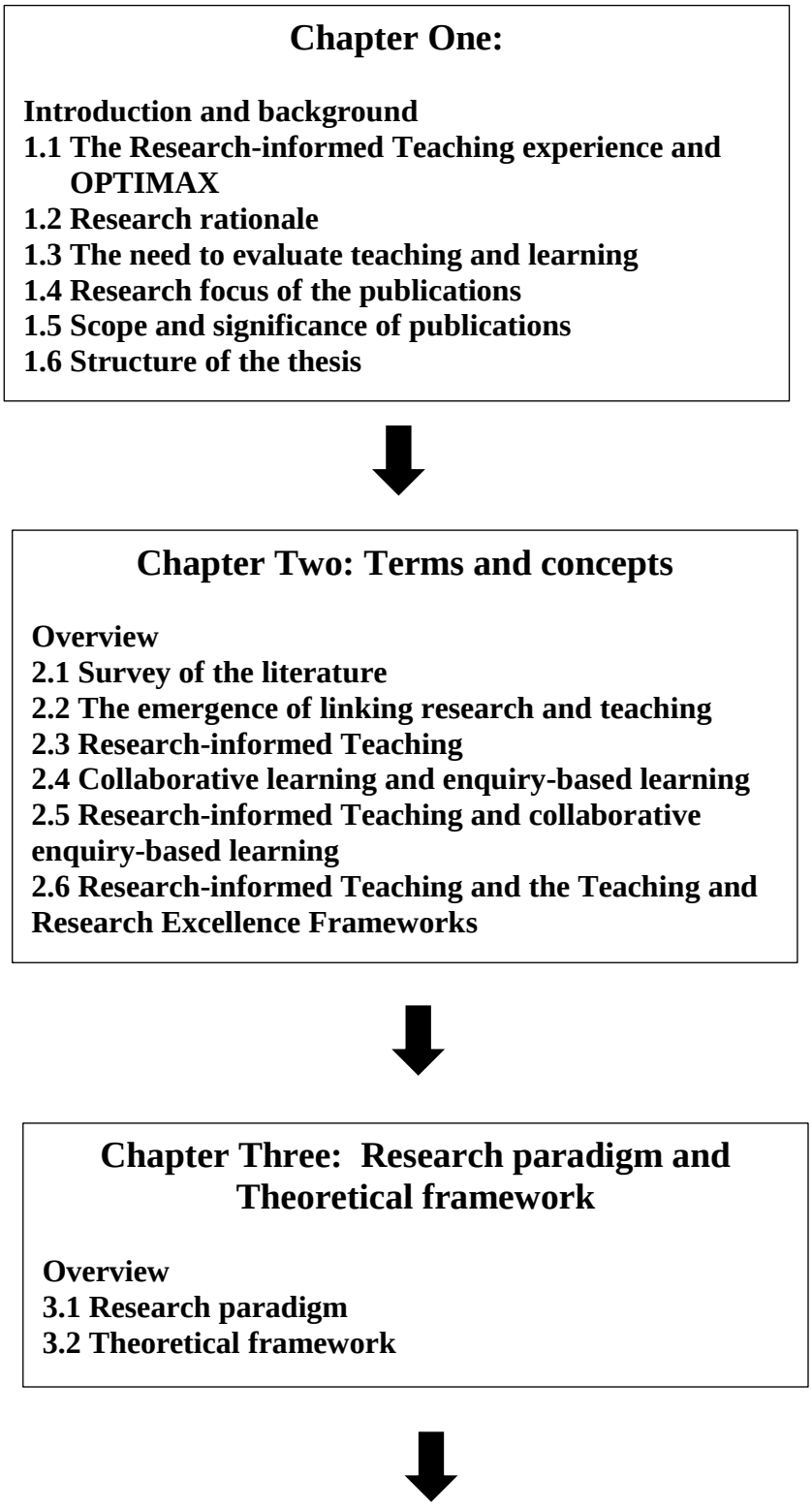
The context of self-efficacy within this thesis correlates with the achievement of research-related outcomes following the completion of RiTe (Kitching *et al*., 2011; Domenech-Betoret, 2017). According to expectancy-value theory (Eccles *et al.*,1983; Wigfield & Eccels, 2000) students' beliefs concerning the degree to which they are confident in accomplishing an

academic task (self-efficacy) and the degree to which they believe that the academic task is worth pursuing (task value) are two key components for understanding students' achievement behaviours and academic outcomes. This un-published paper further extends the research in this thesis by investigating student learning and task value following RiTe.

1.6 Structure of the thesis

The six publications in this thesis are presented in chronological order and provide an account of a range of evaluations and educational research of RiTe and OPTIMAX. The role of RiT and CEBL and the contribution of these towards the student learning experience with RiTe and OPTIMAX is explored in Chapter Two. The student reaction to RiTe and OPTIMAX is understood through the New World Kirkpatrick Model (NWKM) of evaluation and this provides the theoretical framework posteriori for this thesis in Chapter Three. Chapters Four and Five discuss my research process and methods used, analysis and current ongoing research with the development and validation of a psychometric scale to determine task value and student self-efficacy with RiTe. Chapter Five explores the concept of trustworthiness with my data analysis. Chapters Six and Seven discuss findings from this research and considers the main contributions of the published work as well as limitations. Recommendations and further work based on my research are also discussed. Chapter Eight explores the challenges in writing this thesis and takes a reflexive approach by considering processes and influences that may have affected the research outcomes with my publications. Figure 2 summarises the entire PhD thesis layout.

Figure 2: Schematic diagram illustrating the main layout of my PhD thesis.



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Chapter Two: Terms and concepts

Overview

This chapter provides a brief survey and thematic literature review of the terms and concepts used in the thesis including Research-informed Teaching (RiT) and collaborative enquiry-based learning (CEBL). It also explores how linking research with teaching enhances student learning. The potential benefits of using collaborative enquiry-based learning (CEBL) with RiT is then discussed. Finally, the importance of RiT as a performance metric for both the Teaching Excellence and Research Excellence Frameworks is identified.

2.1 Survey of the literature

A literature search was conducted to explore the published literature associated with RiT. This identified an extensive amount of pedagogical literature that discussed the integration of RiT in HE and the benefits (e.g. Elton 2006; Healey & Jenkins 2009; Taylor 2008; Trowler & Wareham, 2008) and challenges of this (e.g. Grant & Wakelin, 2009; Pan *et al*., 2011). Further searches of the published and grey literature identified that much less had been disseminated exploring RiT activities that had used CEBL (Appendix 3). A further literature search focused on RiT within the undergraduate Diagnostic Radiography curriculum was also conducted. This identified work by Bungy *et al.* (2010) that concluded radiography students involved with research, gained a greater understanding of the research process. However, this paper only sought to determine the role of personal tutors and ways of reducing student attrition rates, rather than the integration of research within the undergraduate Diagnostic Radiography teaching and learning curriculum. No other relevant literature was identified.

2.2 The emergence of linking research and teaching

The Boyer Commission on Educating Undergraduates in the Research University (1998) argued that the didactic style of the teaching in American Universities was failing students in terms of adequate preparation for the challenges of professional life or graduate study. The Commission proposed a far-reaching blueprint for change based on making opportunities for student learning through enquiry central to undergraduate education, with the closer integration of research and teaching (Levy & Petrulis, 2011). Similarly, in the United Kingdom (UK) the Higher Education Academy (HEA) called for new models within the undergraduate curriculum that would incorporate 'research-based study' to cultivate awareness of research careers and train students in research skills for employment (Ramsden in Healey & Jenkins, 2009). UK Government policy had also stressed the importance of the linking research with teaching. A House of Commons Select Committee Report 'Students and Universities' (2009) highlighted evidence from students, that found "*Most of the students who responded to our inquiry saw the connection between teaching and research as positive, finding the proximity to research stimulating and the quality of teachers scholarship enhanced*' (para 170). Publications by Griffiths (2004) and Healey (2005) also stated that there should be a greater symbiosis between research and teaching to develop teaching that was research-informed.

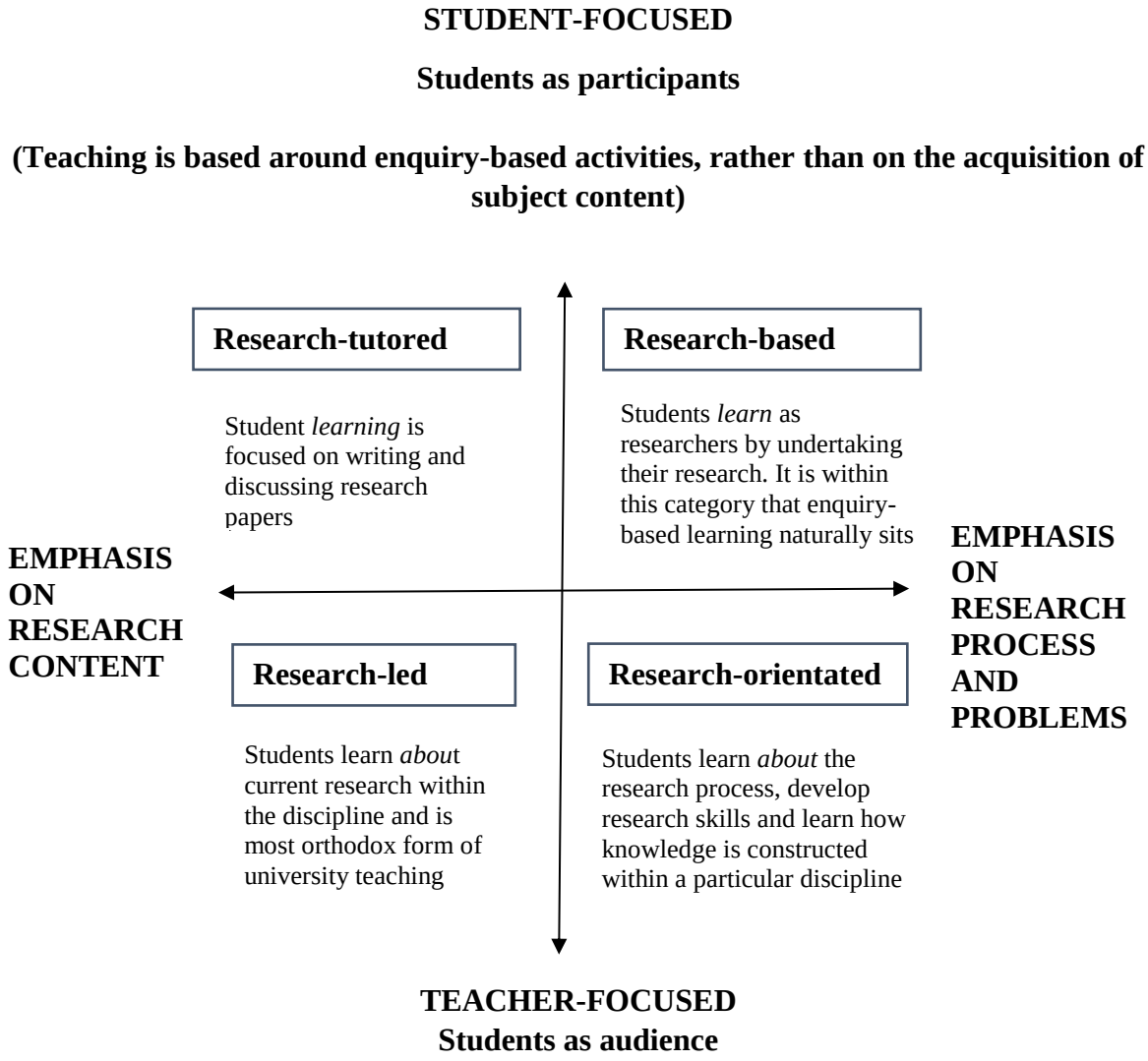
2.3 Research-informed Teaching

RiT refers to the practice of linking research with teaching in HEIs and places emphasis on providing a synergy between the two. However, there is a lack of consensus in the literature as to what is meant by RiT and this has led to various terms being used to describe the link between research and teaching, including the 'teaching–research relationship' (Jenkins, 2004) and the 'research-teaching nexus' (Elton, 2006). Jenkins *et al.*, (2007) defined this link as "…*the connection between research in the discipline or interdisciplinary subjects and student learning*

in and through those disciplines" (p.6). As a result, it can be difficult for HEIs to identify the objectives of RiT and provide strategies that support its development and delivery. Consequently, some students may see 'research' to be the preserve of academics and therefore irrelevant to their needs for applied, practical knowledge required with employability (Nicholson, 2017). This highlights the importance of the careful consideration of what is needed to overcome these misconceptions when developing RiT activities for students (Nicholson, 2017; Buckley, 2011). For example, research by Carr & Dearden (2012) identified that there was no consensus about the meaning and role of RiT by both University management and law academics. Similarly, a report by The Centre for Learning and Academic Development [CLAD] (2012) also identified the perceived lack of understanding amongst both staff and students of what is meant by RiT and concluded that no matter how well justified the claims of delivering RiT may be, it cannot be assumed students will recognise RiT when they experience it without tutor clarification and/or explanation. This serves to highlight that establishing integrative links between undergraduate research and teaching can be complex given levels of understanding amongst students and staff of what is meant or understood by RiT (CLAD, 2012).

There have been several attempts to illustrate the complex and multifaceted nature of RiT. A frequently cited example is the typology developed by Griffiths (2004) that illustrated what was meant by linking teaching and research. Jenkins and Healey (2005) subsequently added further to this typology by identifying that RiT had a range of characteristics and approaches. It is now generally accepted that RiT is a vehicular framework that is all-encompassing and covers a diverse range of characteristics and activities that include four broad types of teaching activities that are either *research-led*, *research-based*, *research-oriented* or *research-tutored* (Nicholson, 2017). Figure 3 illustrates Jenkins and Healey's (2009) framework that represents these four types of RiT.

Figure 3: Framework of the four types and characteristics of Research-informed Teaching (Based on Jenkins & Healey, 2009, p.7; Nicholson, 2017).



Each of type of RiT activity is based upon the degree to which students are actively engaged with the research process (Haslett, 2013). Trowler & Wareham (2008) analysed a range of case studies regarding the depiction of RiT in the literature and noted "*multiple sorts of linkages and relationships being referred to*" (p.4). Despite the number of different definitions of RiT, all of these reflected learning where student engagement with research fell somewhere along a

continuum with students as participants at one end and audience at the other (Jenkins & Healy, 2009; Nicholson, 2017). The axes on the Jenkins & Healy's (2009) framework in Figure 3 also reflects this with the type of research engagement by students either being teacher focused (audience) or student focused (participatory) and whether the emphasises is placed on research content or the process of conducting research.

Furthermore, it has been suggested that the four types of RiT in Figure 3 could be subdivided and that there might be more types of research-led teaching depending upon whether academics use current or past research in their teaching and whether that research was carried out by themselves or by others (Healey, 2005). There are similar arguments about the extent to which teachers facilitating research-based or research-tutored approaches need to be active or experienced researchers (Brew, 2006). Brew & Boud (1995) stated that the key link between research and teaching is learning so that students see research as a process of enquiry into how knowledge is generated and communicated. However, an academic's understanding of RiT is likely to be dependent upon his or her own professional biases or departmental culture. A research-focused academic may favour research-led teaching, whilst a teaching-focused academic may favour research-based teaching. Nonetheless, it is important to acknowledge that RiT can also play a wider role in student learning by equipping students with skills, knowledge and attributes that will make them more likely to gain employment (Jenkins & Healey 2009; Nicholson, 2017).

For the purposes of this thesis, RiT will be presented as an 'umbrella' term that includes the four broad types of RiT activity and student engagement identified in the framework published by Jenkins & Healey (2009) in Figure 3. It is also considered as a process that imparts

knowledge, facilitates learning, develops student research skills and equips students with key skills and attributes for employability.

2.4 Collaborative learning and enquiry-based learning

Collaborative learning (CL), or cooperative leaning, involves groups of students working together to solve a problem or completing a task and there is a wealth of evidence that CL is an extremely effective method in teaching (Laal & Ghodsi, 2012; Biggs, 1999). Higher level thinking skills are developed by CL (Webb, 1982) as students are committed together in the learning process to achieve demonstrable outcomes. Dillenbourg in Lin (2015) defines CL as a situation in which two or more people learn something together. In this definition, 'two or more people' can be interpreted as a pair, a small group with three to five learners, a class of 20–30 students, a community of a few hundred or thousand people, or a society of several thousand or millions of people. The word 'learn' indicates participation in a learning activity, or the accumulation of lifelong work practice. The word 'together' denotes the various types of social interaction, such as face-to-face interaction. Kagan in Lin (2015) highlights four main elements of CL: simultaneous interaction, positive interdependence, individual accountability and equal participation. The concept of CL is largely rooted in Vygotsky's sociocultural theory (SCT) which views learning as being inherently a social process (Dillenbourg, 1999) and mediated with peers (Lin, 2015).

Enquiry-based learning (EBL), also known as inquiry-based learning uses questioning to actively involve students in their own learning and falls under the realm of an 'inductive' approach to teaching and learning that begins with a set of problems or data for the students to interpret (Chu *et al*., 2011). EBL has also been defined as a pedagogy that enables students to experience the processes of knowledge creation. The core ingredients of EBL are:

- Learning stimulated by inquiry, i.e. driven by questions or problems;

- Learning based on a process of seeking knowledge and new understanding;

- A learning-centred approach to teaching in which the role of the teacher is to act as a facilitator;

- A move to self-directed learning with students taking increasing responsibility for their learning and the development of skill;

- An active approach to learning.

(Spronken-Smith, 2008)

The aim of EBL is to develop valuable research skills and prepare students for life-long learning. Within EBL students should achieve learning outcomes that include critical thinking, the ability for independent enquiry, responsibility for own learning and intellectual growth and maturity (Lee *et al*., in Spronken-Smith, 2008). EBL ranges from a structured and guided activity at lower cognitive levels through to independent research where the students generate questions and determine how to research them at higher levels of learning (Spronken-Smith, 2008).

2.5 Research-informed Teaching and collaborative enquiry-based learning

The four types of RiT illustrated in Figure 3 may also be seen fully or partially present in EBL (Nottingham Trent University, 2013). Khan & O'Rouke (2004) identified EBL as encompassing a range of approaches which are summarised in Table 1.

Table 1: Approaches to enquiry-based learning (Adapted from Nottingham Trent University, 2013; Khan & O'Rouke, 2004).

EBL Approach	Example
Case-based learning	A complex case is provided to students and followed with in-class discussion about content and concepts.
Scenario-based learning	Students participate in a 'scenario' designed to stimulate a relevant issue or problem. The scenario may involve an element of role play.
Problem-based learning	An authentic problem is used to define and drive the student learning experience.
Project-based leaning	Students work collaboratively to explore a problem or issue and create a presentation/ product to demonstrate their learning.
Individual research project	A student explores a problem or issue through a structured process of enquiry – this may take the form of a research module or a dissertation.
Field work	A small-scale investigation is undertaken individually or in groups as part of a discipline related field trip.

Tosey & McDonnell (2006) argued that EBL is a process of learning that draws upon research and study skills, but enquiry alone is not reducible to either research or study. However, it is possible to make distinctions with the different forms of EBL and how these may conceptually link with RiT, for example whether the enquiry is structured or open and whether the emphasis is on developing the students' understanding of existing knowledge or creating new knowledge

(Nottingham Trent University, 2013). Spronken-Smith & Walker (2010) proposed three categories of scaffolding where RiT and EBL may sit on a spectrum of research experience:

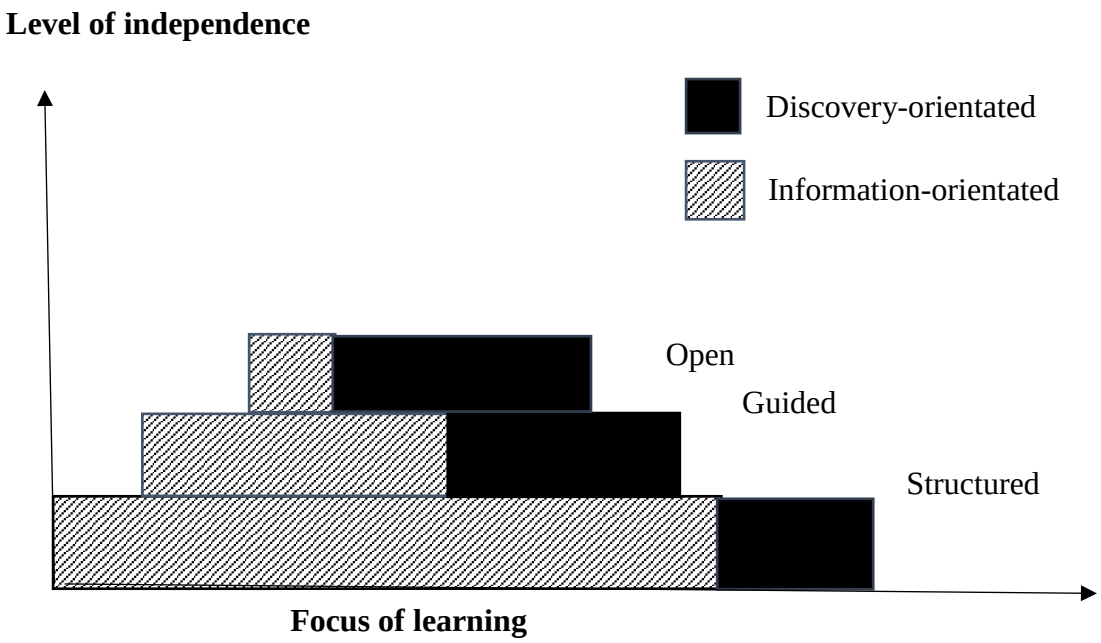
- Structured enquiry: Teachers provide an issue or problem with an outline on how to address it;

- Guided enquiry: Teachers provide questions to stimulate enquiry, but students are self-directed in terms of exploring questions;

- Open enquiry: Students formulate their own questions.

However, this three-category model has been further adjusted to consider whether students work with knowledge in an 'information frame' acquiring existing knowledge or a 'discovery frame' which involves building new knowledge (Spronken-Smith & Walker, 2010; Nottingham Trent University, 2013). The stepped model in Figure 4 illustrates the way in which scaffolding is reduced across these three categories to increase independence and the capacity for research, therefore strengthening the linking of research with teaching and development of student research skills (Nottingham Trent University, 2013).

Figure 4: The elaborated model of enquiry-based learning by Spronken & Walker (Taken from Nottingham Trent University, 2013).



Jenkins & Healey (2009) and Brew (2010) stated that in fact EBL and RiT are complementary and mutually reinforcing with one another and help to focus on learning through enquiry. The teaching within RiTe is based around guided enquiry-based activities, rather than on the acquisition of subject content using a student-centred / research-based approach. Students actively learn by undertaking research that builds on their knowledge and understanding (information-oriented approach).

Studies by Dochy et al., (2003); Harada & Yoshina, (2004); Hu et al., (2008) and Kuhlthau *et al.*, (2007) stated that EBL is effective in promoting learning outcomes such as deep thinking and the ability to apply knowledge and reasoning skills when compared to 'traditional' didactic approaches. One way to implement EBL is by combing this with student group projects or CL (Chu, 2009, Hmelo-Silver *et al.,* 2007). According to Hemraj-Benny & Beckford (2014) students generally have a better appreciation for material that is being taught if they are actively

involved in the process of learning and undertook research that combined CL with EBL as collaborative enquiry-based learning (CEBL) to improve the scientific literacy of non-science undergraduate students. They concluded that by using this approach students improved their appreciation for the scientific world and developed better self-confidence in learning by demonstrating scientific facts when compared to those in the control group who undertook no group or active learning. They also reported that this approach helped to facilitate a strong initiative by students to learn and work together to achieve outcomes.

CEBL within small groups has been shown to increase student achievement (Dong & Guo, 2013; Johnson & Johnson, 1989; Johnson *et al*., 1992) and when guided by clear learning outcomes, students can improve their understanding of a given subject via the negotiated construction and sharing of meaning (Vygotksy, 1978; Rau & Heyl, 1990). By using CEBL within RiTe, learning is facilitated by the sharing of knowledge and experience between students and mirrors the real-world whereby research is often undertaken by a group of researchers collaboratively working together (Milojevic, 2014). Using the framework by Jenkins & Healey (2009), RiTe has the characteristics of a research-based approach to teaching and research using CEBL to promote learning and research skill development.

2.6 Research-informed Teaching and the Teaching Excellence and Research Excellence Frameworks

By introducing more transparent links between research and teaching, a more productive relationship can be created (Senaratne *et al.,* 2003). Jenkins & Zetter (2003) stated that by establishing this link there are three possible advantages - experientially (both students and academics benefit with greater student understanding or knowledge through research); conceptually (benefits from development and co-production of knowledge) and operationally (benefits from reciprocity and economics of combining research and teaching as learning

activities). The Teaching Excellence Framework (TEF) was introduced by the British government in 2016 to provide a mechanism to measure and reward excellent HEI teaching in England. The TEF gives universities a rating based on a set of six 'core' metrics to indicate the level of teaching quality that they can provide indicated by a gold, silver or bronze rating. Whilst the concept of 'excellent' teaching may take many different forms, one area where Universities would be able to seek extra commendation was with RiT. This therefore recognised the benefits RiT offers to students, staff and HEIs as a whole (The Political Studies Association, 2016; Higher Education Academy & University Alliance, 2016).

Lord Stern's independent review of the Research Excellence Framework (REF) in 2016 for the assessment of quality of research in UK Universities also acknowledged the importance of linking teaching with research (Department for Business, Energy and Industrial Strategy, 2016). The review made recommendations that the REF should recognise the impact of research on teaching and encouraged the integration of the TEF with REF through RiT. It was suggested that this would then lead to the co-production of research by both academics and students with potential major impacts on the curricula to bridge the division between research and teaching as well as generating REF submissions for review (Higher Education Funding Council for England [HEFCE], 2016; Department for Business Innovation & Skills, 2016).

The co-existence of both the REF and TEF (now the Teaching Excellence and Student Outcomes Framework), has led to a heightened level of anticipation and expectation around RiT. Policy drivers for this include the endowment of teaching with the same worth as research (together with parity around modes of evaluation), enhancement of the student experience, and embedding transferable skills for employability (Jackson, 2018).

Chapter Three: Research paradigm and theoretical framework

Overview

This chapter discusses the research paradigms and theoretical framework that underpin the publications in this thesis.

3.1 Research paradigm

A research paradigm is a system of beliefs and practices that influence how researchers select both the questions and methods that they use. Morgan (2007) presents the term as "….*ways of experiencing and thinking about the world, including beliefs about morals, values, and aesthetics*" (p.49). This all-encompassing position means that there is a shared belief about how certain research questions should be answered by using either quantitative or qualitative approaches depending on the research question. However, there is a lack of agreement in the literature about what constitutes a paradigm - for example, Kuhn (1962) first used the word to mean a philosophical way of thinking, whilst Lather (1986) considered a research paradigm to inherently reflect the researcher's beliefs about the world that s/he lives in.

I have found it challenging trying to articulate what constituted the research paradigm for my publications in this thesis, for example when starting as a novice researcher I did not consider my own beliefs about the world and how this might shape how I interpreted and acted during my research. Kivunja & Kuyini, (2017) argued that the considerable and glaring overlap of definitions and/or explanations with research paradigms have to do with in part, the fact that social behaviour is fluid and how we think or behave cannot be completely compartmentalised with clear-cut boundaries. Nonetheless, I have come to understand that paradigms can be characterised by their:

- **Ontology** (What is reality?): A realist sees reality as something 'out there', as a law of nature just waiting to be found, whilst relativists believe that knowledge is a social reality, value-laden and it only comes to light through exploring individual interpretations;

- **Epistemology** (How do you know something?): The perceived relationship with the knowledge being un/dis/covered. The researcher is either part of that knowledge or external to it. Knowledge is either governed by the laws of nature or subjective as something interpreted by individuals. This in turn will affect the choice of methodology by the researcher;

- **Methodology** (How do go about finding out?): The strategic approach used by the researcher and whether quantitative or qualitative methods for data collection are used.

(Adapted from Guba, 1990; Morgan, 2007)

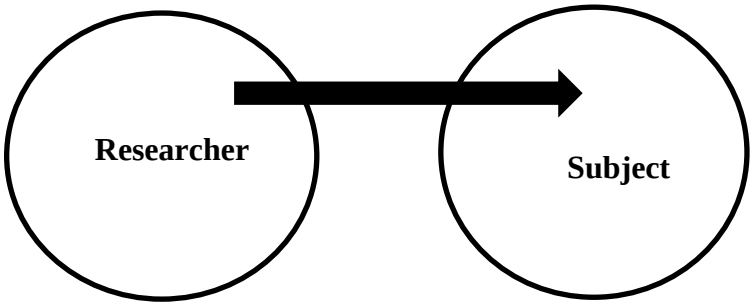
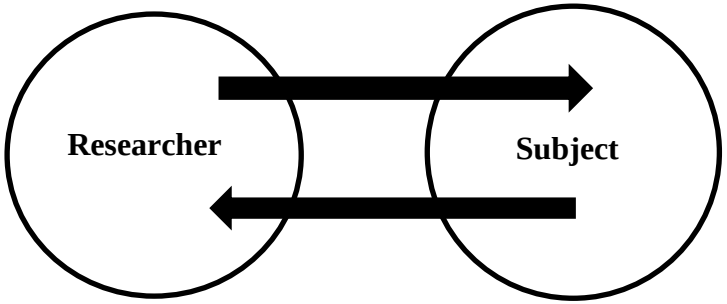
However, Shannon-Baker (2016) has also argued that paradigms are not static, unchanging entities but can help to frame one's approach to certain beliefs about the world which will influence how research questions are asked and answered.

The research publications presented in this thesis are inductive in their approach. I did not set out to test a pre-existing theory, rather I wanted to explore the student learning experience and reaction towards RiTe and OPTIMAX. The perceptions of these learning activities by ATs and CPEs was also then investigated as my research progressed. A qualitative approach was adopted at the initial phase of this research because of its potential to generate new insights by exploring experiences, feelings and reactions with RiTe and OPTIMAX. A qualitative approach

using FGs produced data that helped me to uncover these experiences from multiple perspectives. This approach also acknowledged that as participants in my research they may not only see the world differently to me, but experience it differently also (Denscombe, 1998; Ajjawi & Higgs, 2007). Compared to individual interviews, which aim to obtain singular attitudes, beliefs and feelings, I was more interested in gathering a multiplicity of views as both RiTe and OPTIMAX are multiple-perspective activities undertaken using CEBL and therefore a shared group experience. Individual face-to-face interviews could have obtained more in-depth information as participants may have been more vocalised in personal interviews compared to FG interviews, but as a researcher I was more interested in the exploration of the shared experience and group norms that would be unobtainable from individual interviews (Heary & Hennessy, 2006).

In the further phases of my research, a quantitative approach was used to compliment the qualitative data research findings via questionnaires. Although quantitative data tends to forfeit depth and detail, it helped me to produce empirical data with more breadth of coverage to generalise the views and reactions of RiTe with the whole student cohort and whether these complimented my FG findings; this is in line with Denscombe (1998) and resulted in a mixed methods approach to my research. Ethical approval was sought for each study prior to recruiting participants for my research (Appendix 4). Table 2 compares both the quantitative and qualitative research paradigms and their effect on the relationship between the researcher and subject (indicated by the arrows) and how this influences the researcher's methodology.

Table 2: A comparison of paradigms (Adapted from Lather, 2006; Mackenzie & Knipe, 2006; Reynolds *et al.*, 2011).

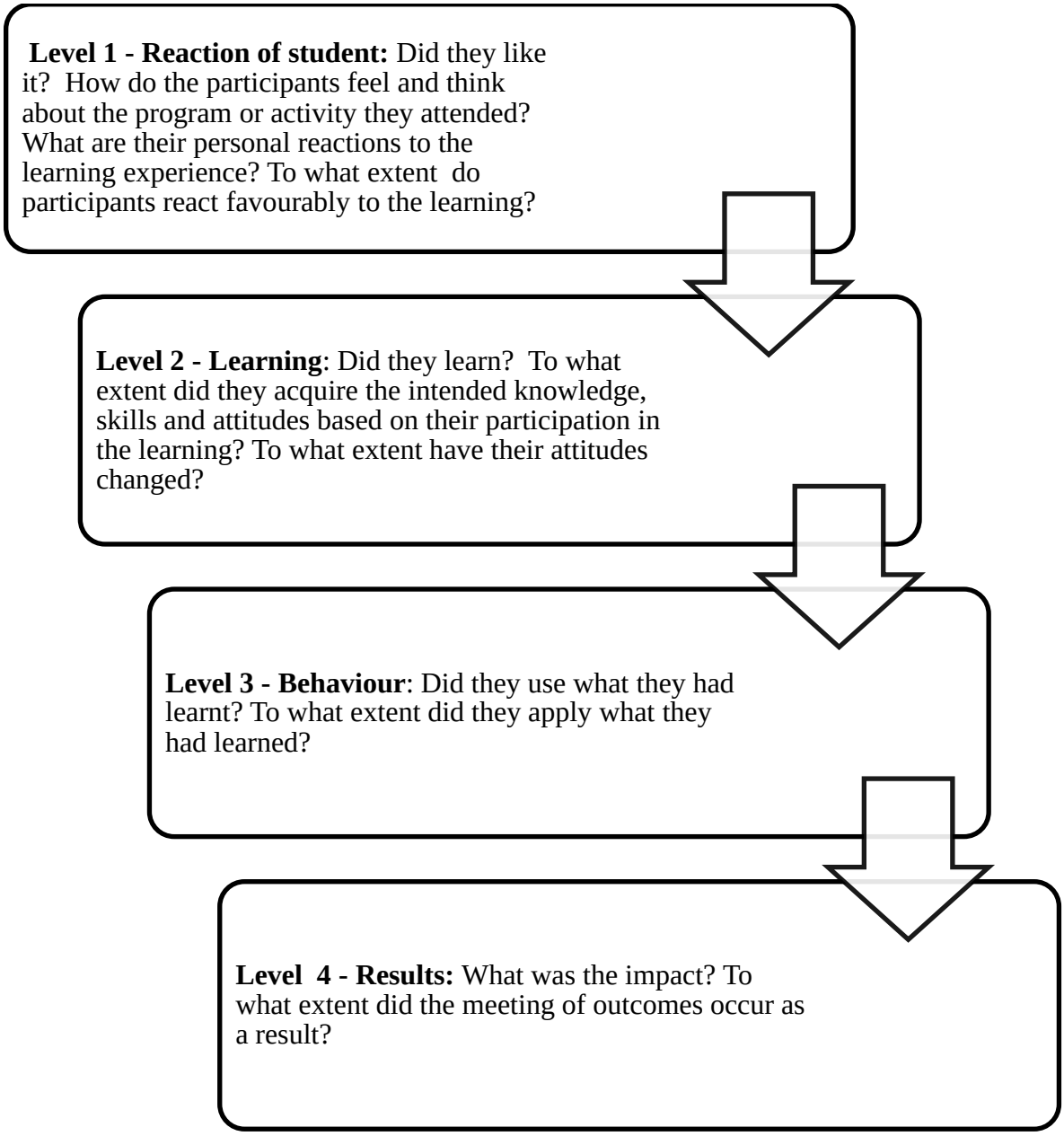
	QUANTITATIVE	**QUALITATIVE**
		
Ontology (Nature of reality/social beings)	Reality is objective and 'found' Single truth Creation of reality of subject by researcher	Reality is subjective and constructed Multiple truths Co-creation of reality between subject and researcher
Epistemology (Perceived relationship with knowledge/research)	Discourse is structured and transparent, reflecting reality Knowing the world Reality can be explained Objectivist – 'how many', 'how much'	Discourse is dialogic and creates reality Understanding the world Reality can be understood or constructed Subjectivist – 'what', 'why', 'how'
Methodology (Discovering and creating knowledge) View on nature of reality)	Experiments Methods are systematic and rigorous	Exploratory Knowledge is constructed through the research process and interpreted through the researchers own values and assumptions
Methods	Measurement and questionnaires	Observation and interviews

I did not intend to use mixed methods for my research from the outset, but by mixing qualitative and quantitative approaches as my research progressed helped me to gather a better understanding of my research phenomena that would otherwise not have been accessible by using one approach alone (Creswell & Plano Clark, 2011; Morse & Niehaus, 2009) and provided confirmatory support for my qualitative findings (Polit & Tatano Beck, 2010). It also helped me to develop as a researcher and gain a better understanding of the value of mixing paradigms as a 'pure' single paradigm approach is not always appropriate for real world research.

3.2 Theoretical framework

The Kirkpatrick evaluation model of learning (specifically The New World Kirkpatrick Model (NWKM)) provides the theoretical foundations for the publications in this thesis posteriori at level 1 (Reaction/Participant Satisfaction). The NWKM was selected as a recognised model for analysing and evaluating the results of training and educational activities and to provide a holistic interpretation and conceptualisation of the publications (Gandomkar, 2018). Kirkpatrick (1959) observed that technical training could be evaluated by measuring learners' reactions and behaviours and wrote a series of articles which identified four levels of evaluation - Reaction, Learning, Behaviour and Results as shown in Figure 5.

Figure 5: The Kirkpatrick model (Adapted from Mavin *et al*., 2010).



Despite its age, the Kirkpatrick model continues to be used in contemporary evaluative research (Kirkpatrick & Kirkpatrick, 2009; Mavin *et al*., 2010). However, a criticism of the original Kirkpatrick model was that the levels had different beneficiaries, for example levels 1-3 concerned learners and level 4 concerned organisations, but teachers were missing altogether. Although it is important to analyse the student experiences of learning, it is also helpful to

evaluate the teacher experience as this can help to improve the quality of their teaching and helps in identifying problems such as a mismatch in expected learning outcomes and student performance (Ramsden, 2003). Another criticism of the original Kirkpatrick model was that it failed to provide any insight into the underlying mechanisms that might inhibit or facilitate achievement of demonstratable outcomes and suggested that success (or lack of success) could be explained simply by examining the end result or outcome (Ramsden, 2003).

In response to these criticisms, a new version of the Kirkpatrick model was introduced in 2016 as the NWKM. The NWKM added new elements that recognised the complexities of learning environments (Gandomkar, 2018; Kirkpatrick & Kirkpatrick. 2016). The most significant change to the original Kirkpatrick model occurred at Level 3 and included the identification of processes that enabled or hindered the application of learned knowledge or skills; for example, drivers that reinforced, monitored, or encouraged the application of learning. Learners' engagement, relevance, confidence and commitment were added to levels 1 and 2 respectively, to broaden the scope of evaluation (Kirkpatrick & Kirkpatrick, 2016). Table 3 provides a summary of the NWKM additions made to the original Kirkpatrick model.

Table 3: New World Kirkpatrick Model additions to the original Kirkpatrick model of learning evaluation (Adapted from Kirkpatrick Partners, 2015).

Level 1: Reaction

The degree to which participants find the training favorable, engaging and relevant to their jobs.

Participant Satisfaction: The original definition measured only participant satisfaction with the training.

New World Additions:

Engagement: The degree to which participants are actively involved in and contributing to the learning experience. Engagement levels directly relate to the level of learning that is attained.

Relevance: The degree to which training participants will have the opportunity to use or apply what they learned in training on the job

Level 2: Learning

The degree to which participants acquire the intended knowledge, skills, attitude, confidence and commitment based on their participation in the training.

Knowledge *"I know it."*
Skill *"I can do it right now."*
Attitude *"I believe this will be worthwhile to do on the job."*

New World Additions:

Confidence *"I think I can do it on the job."*
Commitment *"I intend to do it on the job."*

Level 3: Behavior

The degree to which participants apply what they learned during training when they are back on the job.

New World Addition:

Required Drivers: Processes and systems that reinforce, encourage and reward performance of critical behaviors on the job.

Level 4: Results

The degree to which targeted outcomes occur as a result of the training and the support and accountability package.

New World Addition:

Leading Indicators
Short-term observations and measurements suggesting that behaviors are on track to create a positive impact on desired results

Kirkpatrick's model remains popular for evaluating learning activities, but the basic structure is now more than 60 years old (despite many updates and the introduction of the NWKM). The way in which students learn and how HEIs operate has also changed radically in this time with the term "training" now being been largely replaced by "learning and development" (Moreau, 2017). The Kirkpatrick model has been employed in HEI settings with varying opinions about its efficacy, but its simplicity and systematic approach, means that it remains one of the most widely used and cited models for learning evaluation. It therefore provides a suitable theoretical framework for my research exploring the student reaction of RiTe and OPTIMAX as a proxy for learning (Paull *et al*., 2016; Mawer, 2014). Using the NWKM as a theoretical framework has also led to further research to measure student confidence and task value following participation with RiTe (see Appendix 2).

Chapter Four: Research process and data collection methods

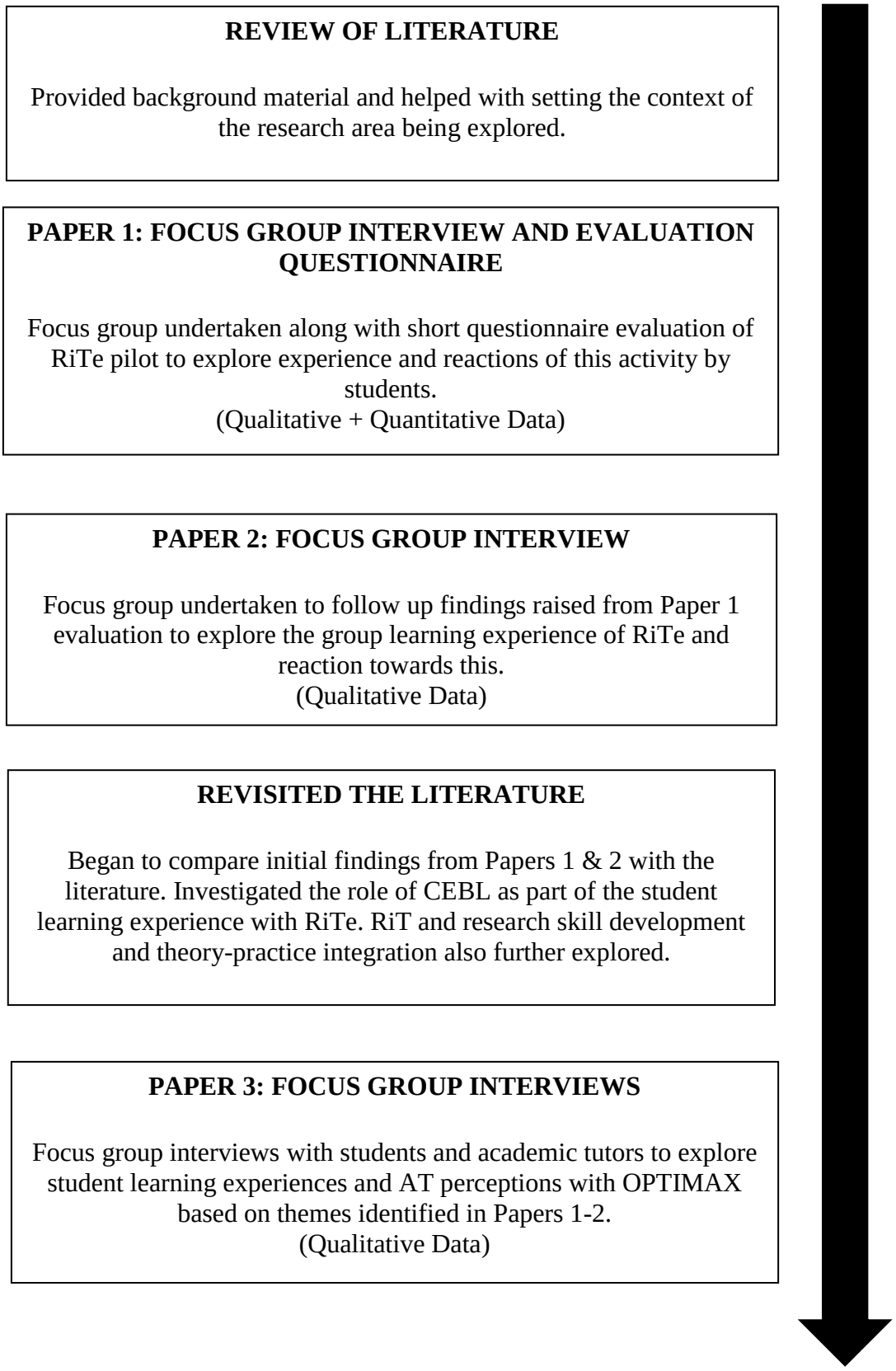
Overview

This chapter discusses the research process undertaken with the publications in this thesis. It also examines the data collection methods used and rationale behind combining qualitative and quantitative methods (mixed methods research).

4.1 Research process

The publications in the thesis represent the paradigmatic foundations of mixed methods research being used in a progressive and exploratory manner. By taking this approach I was more able to more comprehensively explore what students thought and felt about RiTe. Qualitative research has been used in fields such as education, sociology, and anthropology for some time and has started to gain more traction in healthcare research and healthcare professions education (Castleberry & Nolan, 2018). My research data was collected and analysed in two phases: a qualitative phase for **Papers 1 & 2** and a quantitative phase for **Papers 4 & 5**. Although **Paper 1** was predominately qualitative, a small post-activity evaluation questionnaire was also used. For **Papers 3 & 6** a qualitative approach was used as I wanted to explore the student and AT learning experiences of OPTIMAX and the professional and teaching perspective of RiTe by ATs and CPEs respectively. An intentional mixed method research approach was used to develop and validate a psychometric scale to explore task value and self-efficacy scale of year 1 and 2 students with RiTe (see Figure 6).

Figure 6: Research activity and data collection methods for the publications in this thesis.



PAPER 4: STUDENT COHORT QUESTIONAIRE

Data collected using a questionnaire to explore themes from Papers 1 and 2 with whole year 1 cohort to see if they corroborated with the wider cohort - mixed method approach. This also permitted the triangulation of different data types to corroborate findings.
(Quantitative Data)

PAPER 5: STUDENT COHORT QUESTIONNAIRES

Questionnaires used to identify whether learning outcomes at year 1 and 2 constructively aligned within RiTe. Whole year 1 and year 2 cohort surveyed, and the questionnaire design is based on findings from Papers 2 & 3.
(Quantitative Data)

PAPER 6: FOCUS GROUP INTERVIEWS

Focus group interviews with academic tutors and clinical placement educators to further explore RiTe from the academic and clinical tutor perspective as learning activity.
(Qualitative Data)

REVISITED THE LITERATURE / IDENTIFICATION OF FURTHER WORK

Compared findings from Papers 1-6 with the literature (CEBL and the relationship/benefits of using of this with RiT).

Further work needed to explore the degree to which students acquire the intended knowledge, skills, attitude, confidence and commitment based on their participation in RiTe.

ONGOING RESEARCH: DEVELOPMENT AND VALDIATION OF PSYCHOMETRIC SCALE

Mixed method approach used to develop and validate psychometric scale to explore the task value and self-efficacy by year 1 and 2 students following RiTe.
(Qualitative + Quantitative Data)

4.2 Data collection

4.2.1 Sampling

Purposeful sampling was used for the selection of participants to take part with the FGs and questionnaires. This involved selecting participants that had all experienced the phenomenon of interest or had knowledge of this to increase reliability. As Morse and Niehaus (2009) observe, whether the methodology employed is quantitative or qualitative, sampling methods are intended to maximise efficiency and validity. Nevertheless, the sampling was consistent with the aims and assumptions inherent in the use of both qualitative and quantitative methods. For example, quantitative research provides breadth of understanding; whereas qualitative research provides depth of understanding (e.g. feelings of participants towards a particular phenomenon) (Patton, 2002).

4.2.2 Qualitative data collection

Apart from **Paper 1**, I conducted all the FGs as a solo researcher. The FG in **Paper 1** was video recorded and questions were compiled and asked by a member of the academic team as I was still working as a Radiographer and could not attend. This meant that was I unable to influence the line of questioning, but for **Papers 2 & 3** I conducted and collected data using semi-structured interviews that were recorded using digital audiotape. Prior to commencing the FGs, I read preparatory guidance literature (e.g. Denscombe, 1999) on how to conduct FG interviews. Each FG lasted approximately 60 minutes and the FG venue used was a small and intimate room located within the University's premises. This made it easily accessible and in surroundings familiar for the participants. I also asked participants to elaborate upon certain comments and whether they had anything they wished to add or if I had missed any key points during each FG interview.

Field notes were taken and used to act as point of reference during the data analysis. For **Paper 6** data was collected using asynchronous online FGs (OFGs). For each FG I acted as the 'moderator' and used a semi-structured interview approach that included 'triggers' or questions used to guide the discussion (see **Paper 2**, p63, Table 1 Topic plan with focus group triggers and **Paper 6,** p228, Table 1 Semi-structured questions used in both OFGs). These triggers would enable the participants to share their experiences with each other and help identify any degree of consensus or difference of opinion. A set of guiding principles were also used for each FG to ensure confidentially of all participants and to encourage all participants to express and share ideas (see **Paper 2,** p63, Table 2 Focus group guiding principles).

Using FGs allowed me to study how meanings, interpretations, and narratives were socially constructed by the participants. Although FGs do have a potential weakness with participant perceptions being created within the group and not on a one-to-one basis, this approach did allow participants to share and compare a multiplicity of views and experiences with one another that helped to stimulate further debate (Smith, 2017). This made the choice of FGs for my research an appropriate methodological tool for my data collection when exploring the student learning experience of RiTe and OPTIMAX.

4.2.3 Quantitative data collection

To further evaluate and gain a better understanding of the student experience of RiTe quantitative research was undertaken using opinion/attitudinal questionnaires (**Papers 4 & 5**). Questionnaires were used to collect descriptive statistical data from the whole year 1 and year 2 student cohort that could be generalised and help to provide further insight into the breadth of the student experience with RiTe (National Institutes of Health [NIH], 2018). Data gained from the FGs along with appropriate literature on questionnaire design (e.g. Denscombe, 1999)

was used to aid the construction of questions to explore key findings identified from the FG research with the wider year 1 and 2 cohorts. Each questionnaire had a pre-set structure with the aim of collecting student opinions about RiTe.

Although I had used a small questionnaire evaluation in **Paper 1**, qualitative findings had not been used to develop the items of the questionnaire and instead the questions had been based upon the University's module evaluation questionnaire (MEQ). I did not use or search for validated items from other questionnaires which had explored RiT and undergraduate student learning experiences of this with my questionnaires in **Papers 4 & 5** which could be considered a limitation of their reliability and validity. Qualitative data analysis from the FGs yielded specific themes related to the phenomena being researched – namely the student experience of RiTe, RiTe and the diagnostic radiography curriculum, RiTe and clinical skills development, RiTe and research skills development and each of these themes were turned into questionnaire items for exploration with the wider student cohort in **Paper 4**. The questionnaire was then further adapted for **Paper 5** by amending the questions to elicit responses based on knowledge transition from year 1 to 2.

When developing the questionnaires, I determined what I wanted to measure and to ensure applicability, I generated a pool of questions related to each theme (e.g. *'I found RiTe to be an enjoyable and stimulating learning experience*'; '*I feel that RiTe has helped develop my clinical skills further*'). The scale of measurement (level of agreement) to each question on the questionnaire was determined using a 5-point Likert scale. The pool of questions was reviewed by two researchers with experience of educational research or quantitative method research designs. Each questionnaire was piloted with a small sample of students and selected ATs as part of a validation process to determine the clarity and appropriateness of each statement

(DeVellis, 1991). I felt that that these participants would have the range of knowledge of RiTe and questionnaire design to complete, assess and provide feedback on the questionnaires. The data from the questionnaires was mostly quantitative, but there were open ended items where qualitative data was captured so that respondents could expand upon their answers to items if they wished to elicit reasons for their response to an item (Denscombe, 1998). These qualitative comments were used in **Papers 4 & 5** to support my quantitative analysis.

Questionnaire reliability was also ensured by the negative-wording some of some of the closed items to minimise affirmation bias (Mcleod *et al.*, 2000; Altermatt, 2006). All questionnaires were completed using the Bristol Online Survey (BOS) tool (http://www.onlinesurveys.ac.uk/). Regular reminders were sent out to participants and this led to a response rate of 54% and 67% for **Papers 4 & 5** respectively; for an online questionnaire the expected completion rate is usually around 33% (Nulty, 2008).

4.3 Mixed methods research

Shannon-Baker (2016) viewed mixed methods research as the intentional mixture of both qualitative and quantitative approaches in a single research study. This mixture, or the integration of these two approaches, can take place in either the philosophical or theoretical framework(s), methods of data collection and analysis, overall research design, and/or discussion of research conclusions. Research issues most suitable for mixed methods are those in which a quantitative or qualitative approach alone is inadequate to provide a comprehensive understanding of a research problem.

Mixed methods research values both the qualitative (subjective) and quantitative (objective) research processes. Teddlie & Tashakkori (2009) stated that combining questionnaires and

interviews in a single research study brings together the advantages of breadth and depth associated with these two methods. Although I did not set out to use mixed methods research at beginning of my research, by using both qualitative and quantitative research methods I was able to confirm the credibility of my findings and use a process of triangulation to provide a comparison of the results from these different methods so that I could assess the extent to which my findings from the FG data agreed and corroborated with my questionnaire findings (Patton, 1999; Caillaud & Flick, 2017).

4.4 Ongoing research using mixed methods

The research in this thesis has evaluated the student reaction to RiTe as proxy for learning but has not explored the student's beliefs towards RiTe (task value) and confidence in their ability to perform actions following their engagement with RiTe (self-efficacy). My ongoing research is currently developing and validating a psychometric scale to investigate student attitude, confidence and commitment with research skills development following RiTe (NWKM Level 2 & 3). This is important area for my research as self-efficacy beliefs affect how consistently and effectively students can apply what they know, making this a good predictor of performance with learning outcomes (Rowbotham & Schmitz, 2013).

A mixed methods research design was used to collect data and comprised of three distinct stages which included scale creation, face and content validity and construct validity and reliability of the scale. An FG of experts was used to ensure that the scale items would measure what they claimed to be measuring and that they comprehensively represented the construct being measured to avoid error in measurement. Following face and content validity testing, the scale was pilot tested via a second FG of year 3 students and a newly qualified radiographer who had all experienced RiTe for validity and reliability. The purpose of this was to pre-test the scale

and ensured that potential respondents understood the wording of the scale items to avoid any misinterpretation. A purposive sampling technique was used to collect data by administering the scale to the whole year 1 and year 2 student cohort following their attendance with RiTe. The creation phase of the scale included item identification, generation and appropriateness and scale items were created using a combination of findings from my earlier research and relevant literature (Appendix 2).

Chapter Five: Trustworthiness of my data analysis

Overview

This chapter discuss the concept of trustworthiness and the steps used in my analysis of the data with the publications in this thesis to ensure rigour with my research.

5.1 Trustworthiness

Trustworthiness refers to the degree of confidence in the interpretation and processes used to ensure the quality of a study (Pilot & Beck, 2014). As a researcher it is important to establish the protocols and procedures used with the data collection and analysis to ensure outcomes are considered trustworthy or credible by those reading the research findings (Amankwaa, 2016). For qualitative research, methods used to establish trustworthiness include credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985; Murphy & Yielder, 2010). For quantitative research, methods used to establish trustworthiness include internal validity, external validity, reliability, and objectivity (Yilmaz, 2013).

As a solo researcher for the publications in this thesis I have been involved in the delivery and evaluation of RiTe since inception. I have investigated the student learning experience of RiTe over the past 6 years and my prolonged engagement within this will have enhanced the credibility of my analysis and identification of concepts and themes (Murphy & Yielder, 2010). However, I will have also brought a specific knowledge base and set of preferences that may have influenced the way in which the themes were derived from my qualitative data. Therefore, it is important that as a researcher I am reflexive in order to explain my position and influence on the research (Gilgun, 2010) and this is discussed further in Chapter Eight.

5.1.1 Qualitative data analysis

For **Paper 1**, I transcribed a video recording of the FG verbatim into a written format to ensure that I captured a word-for-word reproduction of the recorded data for my analysis. A broad surface content type analysis was used to explore the participant experience by staying very close to the transcribed text. I used a quantitative approach to note reoccurring concepts to help generate codes and I did not seek to find any underlying meaning in the text. I then went back through the transcript and looked at the relationship of each of the codes and grouped these together to develop categories that described the student experience of RiTe. For **Papers 2-4** I also transcribed the FG data verbatim into a written format from the audio recordings, but as recommended by Denscombe (1998) I also made field notes to act as 'memory joggers' during each FG to prompt me to go back and explore any areas that I felt needed further clarification. These notes also helped to provide a permanent record of my interpretations or observations of what was said so that I could refer to back to these during my analysis (Appendix 5).

For **Paper 2** I followed a similar process as with **Paper 1** by immersing myself in the data when analysing and generating codes and categories but attempted to explore their underlying meaning further by going back and re-reading my notes and transcripts to better understand what the text was talking about (Bengtsson, 2016) (Appendices 6 & 7). As the participants did not always speak in finite sentences, some sentences needed editing into a format that was understandable to me although a consequence of this process may have been the loss of some authenticity (Denscombe, 1998). Analysis of the transcripts was undertaken using Microsoft Word as this allowed me to highlight codes using different colours and to make notes or record my interpretations of the data from my field notes; with **Paper 1** I had previously done this manually using paper and coloured marker pens. The findings of the FG in **Paper 2** identified that the students found CEBL within RiTe a positive aspect of their experience of RiTe as they

were able to share, and co-produce knowledge as seen in Table 4 which I hadn't previously identified in **Paper 1** or indeed had anticipated. Following my analysis with **Paper 2** I then reviewed my categories against the literature. This also provided the impetus to further explore the role of CEBL and the student experience in my research. Interestingly, analysis of the data also unearthed issues around student leadership with translating this new knowledge into practice following RiTe which also was unexpected finding from my research.

Table 4: Example of generation of a category from several related codes.

Code (with example quotes)	**Category**
Interacting with other people / co-production of knowledge: *R2: It was good to get experience of interacting with other people* Working in a group: *R8: We got on well in our group and I liked group working* Learning from others in the group: R4: *There were members of the team who come from other backgrounds and they were learning about how to do an experiment with the rest of the group*	Student holistic experience of RiTe Sub-category: *Positive student learning experience → collaborative and group learning / working*

In the next phases of my research I wanted to further explore the concepts raised in **Papers 1 & 2**, but also my interpretation of the qualitative data and used thematic analysis (TA) with **Papers 3, 4 & 6** (Yin, 2011**)**. Nowell *et al.* (2017) argue that TA can be used to produce insightful findings from qualitative data and that by using sound and respected data collection and analysis techniques such as TA, I would be able to build trustworthiness and credibility within my publications (Yin, 2011). A central issue with the analysis of qualitative data is that

the participants' meanings and social reality are appropriately conveyed in the final research report. A text may involve multiple meanings and their identification requires a process of careful analysis in which these meanings are uncovered and conveyed. There are number of similarities between qualitative content analysis and TA (e.g. attention to both description and interpretation in data analysis and the consideration of context of data), but with content analysis categories reflect a descriptive level of analysis of the text. I wanted to use TA to elicit the essence of the participant's experiences so that I could generate 3-5 themes that would help me to further characterise the learning experience of the participants with RiTe and OPTIMAX especially following my findings with **Paper 2** (Vaismoradi *et al*., 2016).

Following a review of the literature I could not identify one key text on how to conduct TA and there was no clear agreement about how researchers can rigorously apply TA. This issue has also been identified by Nowell *et al.* (2017). Several guides on TA have been published by authors such as Guest *et al*., (2011), Braun & Clarke, (2006), Nowell *et al*., (2017) and King (2004) and each of these have identified several key similarities with the process of TA. I therefore attempted to synthesise these processes in my analysis of the data but maintained an iterative and reflective process throughout. I also reviewed my themes against the literature and my previous research findings following analysis. The phases I followed in establishing trustworthiness with my qualitative data are illustrated in Table 5.

Table 5: Establishing trustworthiness during each phase of my thematic analysis (Adapted from Nowell *et al*., 2017).

Phase of thematic analysis	**Means of establishing trustworthiness**
1. Familiarisation with the data	Transcribed and re-read the data, noting down initial ideas. The transcribed text was read through several times to obtain a sense of the whole. Documented thoughts and concepts to review in the literature. Documented thoughts about potential codes/themes. Kept records of all my field notes and transcripts.
2. Generating initial codes	Coded interesting features of the data in a systematic fashion across the entire data set. Revisited the data, reflected on specific characteristics of the data. Identified important sections of text as they related to an issue in the data. Boyatzis (1998) suggested that a "good code" is one that captures the qualitative richness of the phenomenon. Sections of text were coded in as many different themes as they fitted, sometimes being un-coded and then re-coded as many times as deemed relevant (Braun & Clarke, 2006)
3. Searching for themes:	A process of sorting and collating all potentially relevant coded data extracts into themes was then performed (Braun & Clarke, 2006). Themes were not dependent on quantifiable measures, but whether they captured something important in relation to my overall research question e.g. the student learning experience (Braun & Clarke, 2006).
4. Reviewing themes:	Themes and any subthemes were reviewed. This helped me to determine what aspect of the data each theme captured and to identify what was of interest and why (Braun & Clarke, 2006). As suggested by Braun and Clarke (2006) I attempted to create theme names that were punchy and immediately gave the reader a sense of what the theme is about. I then went back and read through my data and checked my coding at least twice (King, 2004). This also increased the

	probability of developing credible findings (Lincoln & Guba, 1985).
5. Defining and naming themes:	As suggested by King (2004) as a solo researcher I consulted outside experts (PhD supervisors) to determine whether my themes were sufficiently clear and comprehensive. Discussion of themes had with PhD supervisors, themes were reviewed with relevant literature and compared with my previous findings.
6. Producing the report:	The final analysis. I undertook a process of selecting vivid, compelling extract examples/extracts from my data and related these back to my analysis and research question. I also reviewed and linked themes and concepts with relevant literature in my publications.

Themes were reviewed and assessed as to whether they encompassed all the codes developed from the data, and if they could be combined or subdivided into further themes. In the final stage of my analysis, themes emerging from the coded data were used to develop a narrative to help contextualise my understanding of the participants perspectives and experiences of RiTe and OPTIMAX (Chapman *et al*., 2015). For **Papers 3 & 6** I also used two FGs and once I had coded and generated themes from these data I determined if these themes could be triangulated between the FGs. This helped to identify areas of agreement as well as areas of divergence between each set of FG data as well providing further trustworthiness of my findings (Patton, 2002).

For **Paper 6** I used OFGs to allow the easier participation with my research by CPE and ATs. I had originally intended to conduct the FGs for **Paper 6** face to face as I had assumed that this was the 'gold standard', but there were difficulties with organising a convenient time for the CPEs and ATs to attend for separate face-to-face FGs. After exploring the literature and

following discussions with my PhD supervisors I decided to conduct asynchronous OFGs for both the ATs and CPEs instead. I did have concerns that this approach might be perceived as solution to my problem rather than what was best for my data collection and could impact on the quality of the data collected. Nonetheless, this approach removed timing and location constraints for both FG participants and did not seem to impact on the quality of discussion and data collection. Following my experience with using OFGs I used a similar method when developing and validating the psychometric scale in Appendix 2. This approach also led to a greater equality of participation by each FG group member as they could contribute as and when they wished without timing and location constraints (Nunamaker, 1997).

For **Paper 6** I also followed the fifteen-point checklist of criteria for good TA by Braun & Clarke (2006) which can be seen in Table 6, which I had identified following reading their article on using TA in psychology research to further ensure trustworthiness of my data analysis.

Table 6. The fifteen-point checklist of criteria for good thematic analysis (Braun & Clarke, 2006).

Process	No.	Criteria
Transcription	1	The data have been transcribed to an appropriate level of detail, and the transcripts have been checked against recordings for "accuracy"
Coding	2	Each data item has been given equal attention in the coding process.
	3	Themes have not been generated from a few vivid examples (an anecdotal approach), but instead the coding process has been thorough, inclusive and comprehensive.
	4	All relevant extracts for all each theme have been collated
	5	Themes have been checked against each other and back to the original data set.
	6	Themes are internally coherent, consistent, and distinctive.
Analysis	7	Data have been analysed – interpreted, made sense of - rather than just paraphrased or described.
	8	Analysis and data match each other – the extracts illustrate the analytic claims.
	9	Analysis tells a convincing and well-organised story about the data and topic.
	10	A good balance between analytic narrative and illustrative extracts is provided.
Overall	11	Enough time has been allocated to complete all phases of the analysis adequately, without rushing a phase or giving it a once-over-lightly
Written report	12	The assumptions about, and specific approach to, thematic analysis clearly explicated.
	13	There is a good fit between what you claim you do, and what you show you have done – i.e., described method and reported analysis are consistent.
	14	The language and concepts used in the report are consistent with the epistemological position of the analysis.
	15	The researcher is positioned as active in the research process; themes do not just "emerge"

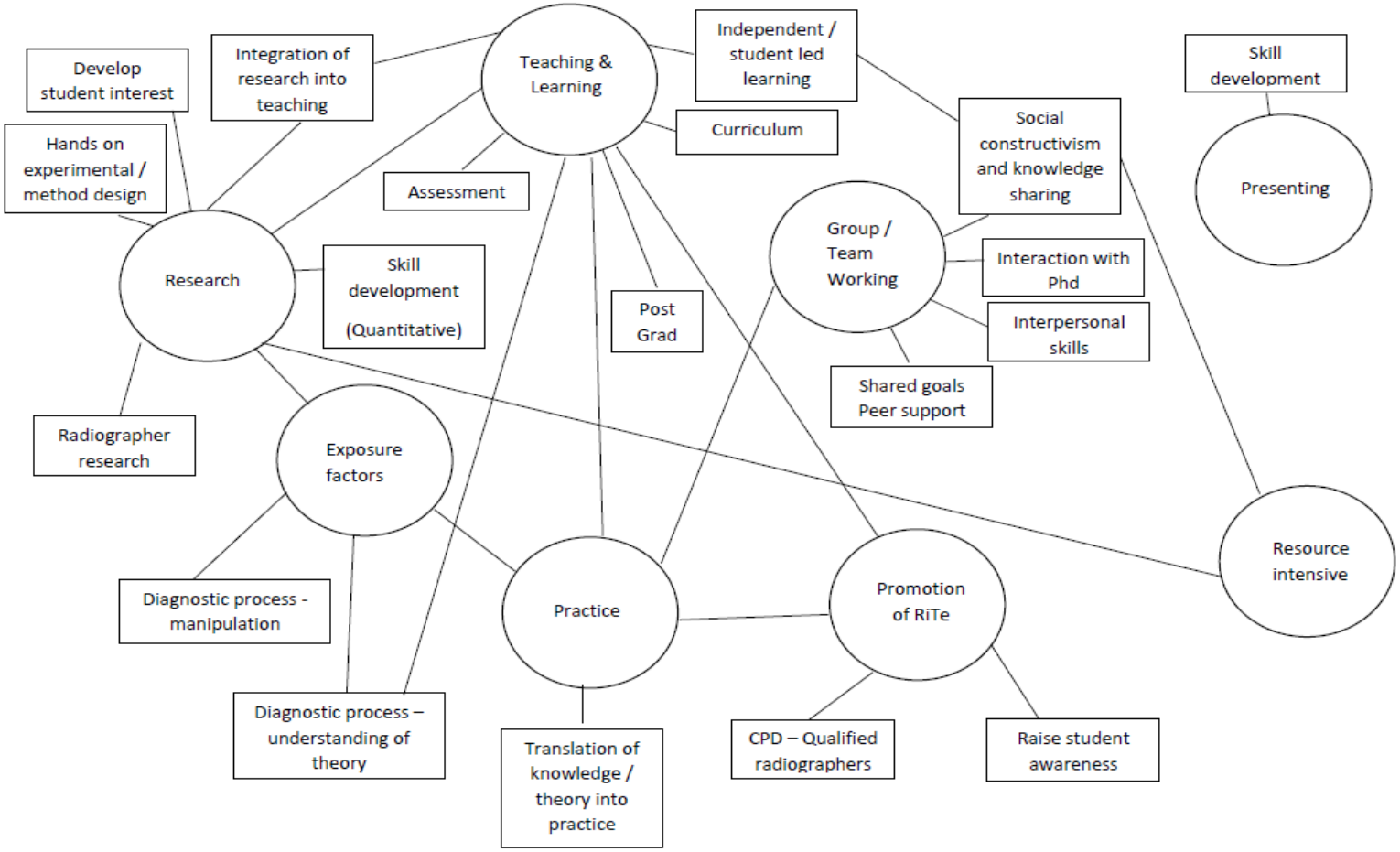
By using the checklist in Table 6, I tried to avoid merely paraphrasing the data by developing an analytic narrative to ensure dependability and credibility of the results (Braun & Clarke, 2006; Gray, 2014; National Health Service [NHS] Leadership Academy, 2017). This was achieved by going beyond, the 'surface' of the data, and helped to provide a more detailed analysis and account of the AT and CPEs' perceptions and experiences of RiTe (Braun & Clarke, 2006) as can be seen in Table 7 and Appendix 8.

Table 7: Example of data extract with codes applied from academic tutor focus group from Paper 6.

Data extract	**Coded for**
Yes, if the research problem is selected carefully (1) to match their required learning at the point in their curriculum (2). Sometimes students may need a little help to see the links with clinical practice – involvement of placement in this process would really help here (3). (*Academic Tutor 5 (AT 5) 5:25:15/9/2015*)	1. Research/Research skills development 2 Linking the research activity with teaching 3. Linking theory with practice

The codes were then used to generate themes and created an initial thematic map as illustrated in Figure 7 to help me identify concepts and how these linked with the themes. During my PhD supervisor meetings, I also attempted to share my interpretations of the participants' experiences from each of my FG data analysis and how I had interpreted my findings.

Figure 7: Initial thematic map, showing nine main themes from Paper 6. Initial themes presented in circles.



5.1.2 Quantitative data analysis

The questionnaires in **Papers 4 & 5** consisted of 25 items contained within 5 key themes (see **Paper 4,** p102, Figure 1 RiTe student experience online questionnaire). Results were tabulated question by question and the frequency of responses to each item or question. The data was analysed using Microsoft Excel and descriptive statistics were used to describe the frequency and distribution of responses to each item (Denscombe,1999). Responses were converted into numerical scores and items that had negative wording (e.g. "I do not", "I felt that I did not") were reversed for scoring purposes so that all responses were unidirectional. The data were presented using histograms to (for example see **Paper 4**, p104, Figure 3 Student experience of RiTe) (Denscombe, 1998). No other statistical tests were employed, for example I did not use Cronbach alpha, or factor analysis to validate and ensure reliability of my questionnaire items (Sullivan *et al*., 2013; Boynton, 2004). However, these tests were used with the development of my psychometric scale in Appendix 2.

By using a questionnaire in **Paper 4** I was able to triangulate both the quantitative and qualitative data with the previous FG findings from **Paper 2**. This enabled me to further investigate whether there were connections or links with the categories identified with the FG findings in **Paper 2** and the wider student cohort, using two independent methods (Creswell, 2015). This helped me to confirm that student cohort felt RiTe was a valuable, relevant and interesting learning activity and therefore complimentary to the findings in **Paper 2.** The role of CEBL was seen to be a key element of their learning experience along with aiding their development of research skills. The questionnaire used in **Paper 5** also helped to confirm the constructive alignment of learning outcomes with RiTe in years 1 and 2. Analysis of the data also identified that the learning in RiTe for year 2 students was at an appropriate level (task complexity had been altered to account for this) and commensurate with expected Framework

for Higher Education Qualification (FHEQ) level descriptors. Students in year 2 also continued to see RiTe as being a relevant and interesting learning activity on the course.

5.2 Summary

By using a mixed methods approach in my research, I was able to use both qualitative and quantitative sources of data to help me better understand the phenomena being explored (Patton, 1999; Caillaud & Flick, 2017). This also enabled me to use a process of triangulation to check and corroborate my findings from the FG research by being able to generalise to the wider student cohort. However, it is worth mentioning that the students were already used to group based learning with problem-based learning (PBL) on the course, so this might have had influence on this aspect with RiTe and the outcomes of my results. Nonetheless, the concept of CEBL was also seen as a key factor with the success of OPTIMAX by students and ATs.

Chapter Six: Discussion and research contributions

Overview

This chapter discusses the findings from the publications in this thesis following the scope and aims set out in Chapter One. It also provides a comprehensive review of the main contributions and addition to knowledge the publications have made to the current body of literature.

6.1 Discussion and contributions

Mixed methods research was used to collect and analyse quantitative and qualitative data. This helped to provide a broader perspective of my research aims and increase the trustworthiness of my findings by providing two sources of data to assist with my understanding of the phenomena I was exploring (McKim, 2017). By using the NWKM as a theoretical framework, the publications in this thesis reaffirm that the student's perspective and reactions towards learning activities are an important area of contemporary teaching and learning research; it is important as a teacher to know whether devised courses or activities are working in the ways intended or whether there are aspects that could be changed or improved (Tight, 2012; Kirkpatrick, 1967).

The publications in this thesis found that RiTe was seen by students, ATs and CPEs as a valued learning activity that facilitated understanding and knowledge by linking theory to practice as well as developing student research skills by linking teaching with research (**Papers 1-2 & 6**). Data gained from quantitative research also helped to further corroborate and support my qualitative findings regarding RiTe as a stimulating and enjoyable learning experience appropriate to the students' level of learning (**Papers 4 & 5**). A student-centred, research-based approach to learning by students via CEBL was seen a key part of the student learning experience within RiTe and this was corroborated in **Paper 4** by the year 1 student cohort and

identified with OPTIMAX in **Paper 3**. These findings therefore support and contribute towards building on knowledge by Griffiths (2004) and Healey (2005) and linking of research with teaching. However, the publications also add to the body of knowledge by authors such as Jacques & Salmon (2007), Cohen (1994), Jackson & Williams (1985) and Vygotsky (1978), who found that working in small groups benefits students by providing them with opportunities to critically explore material, construct knowledge and develop higher order thinking skills through active participation with learning.

Using CEBL within RiTe and OPTIMAX supported learning through discussion (co-production of knowledge), developed research and interpersonal skills, and helped students to identify weaker skills or knowledge that needed further development (Higgins *et al.,* 2013a; Higgins *et al.,* 2013b; Higgins *et al.,* 2014a; Higgins *et al.,* 2017a; Higgins *et al.,* 2017b). Goodyear & Zenios (2007) also identified that students' engagement with learning activities that use CEBL facilitated their capacity to understand and participate with different ways of creating knowledge within different contexts. Key employment skills such as communication and team working were also identified by ATs and CPEs when exploring their perceptions of RiTe as part of my research (Higgins *et al.*, 2017b). Spronken-Smith & Walker, 2010; Simons, 2006, Villa *et al*., 2013 have also described benefits of using CEBL with RiT, which include greater achievement of higher order learning outcomes and enhanced student employability via the development of key skills such as communication, critical thinking, problem solving and team working.

Despite a body of literature supporting the linking of teaching and learning with RiT, this research has identified several important implications when developing RiT activities and the role of CEBL; for example, with CEBL there is an increased attention to the research process

(skills development) by students which includes collaboration, team working and knowledge construction processes:

> *"Great team work- learnt from my peers."*

> *"Overall, I felt RiTe was a good experience into how to do research and I know some areas that I need to develop further, such as data analysis…"*
>
> (Higgins *et al*., 2014a)

Both RiTe and OPTIMAX offer a useful stepping stone for novice researchers undertaking their first steps into an area of practice which may previously had been relatively inaccessible (Manning-Stanley, 2017). A greater awareness of how research can inform practice is generated and students are able to better understand which practices work best and why. This supports the link between research skill development and learning via active participation with CEBL as reported by Imafuku *et al.,* (2015) as students can share experience and knowledge:

> *"Unlike some of the other group members, I don't have a science background. I have learnt a lot from it [RiTe]*

> *"I think that it was good educationally. All of the things we get told about in lectures… We don't actually get to spend time looking at images and trying to see what that is in practical terms"*
>
> (Higgins *et al*., 2013a)

However, the development of leadership skills in students should also be considered within the wider undergraduate curriculum when developing research skills. Research findings seemed to indicate that following participation with RiTe students felt unable to share or challenge qualified practitioners with the knowledge they had gained. The reason for this was unclear, but

may be due to a lack of confidence in expressing concepts or feeling disempowered in the clinical learning environment:

> *"I have learned that I'm not going to bring the kVp up by 5 or whatever unless it is justified for a good reason. I never dare tell the radiographer to*"
>
> (Higgins *et al*., 2014a)

However, students did feel more confident in sharing this knowledge with their peers, but only following qualification did the students feel confident enough to share their knowledge acquired from RiTe:

> *"It's more of having self confidence really, once your qualified you know that you have the authority to be able to help people and pass on the information that you have"*
>
> (Higgins *et al.,* 2014a)

Without adequate training in leadership skills students may feel unable to challenge the status quo to develop practice. Developing undergraduate student leadership skills may also provide the impetus to challenge traditional practices that may not necessarily be evidence based.

6.1.1 Implications of the publications

Both RiTe and OPTIMAX mirror real world research practices and support the notion that regardless of methods used, researchers work with others in formulating research questions, collecting data, and interpreting findings (Garland *et al.,* 2006). One of the aims of the Society and College of Radiographers Research Strategy [2016-2021] (SCoR, 2015) is to '*Develop a radiography workforce that engages critically with research to ensure that care provided to service users is based on the best available evidence*' (p6). A recommendation in order to achieve this aim is to embed research at all levels of radiography practice and education by

having radiography courses that contain components to develop critical research appraisal skills. By using a model like RiTe, this may help to achieve this aim by developing research skills from year 1 and engaging undergraduate radiography students in research and teaching activities that link with evidence-based practice. This approach may also help to achieve another aim of the SCoR [2016-2021] Research Strategy which is to '*Foster a culture across the radiography profession that values research and evaluation activities as a core part of delivering high quality patient care for all*' (SCoR, 2015 p7).

However, a large amount of time and resource is required to deliver and facilitate RiTe especially as this uses CEBL. To overcome this an inclusive approach was adopted by involving a range of ATs as well as PhD students and a specialist technician. There were some difficulties with getting some students to fully engage with RiTe and Meyers (1997) suggested that group members who contribute less can lead to other group members reducing their effort and commitment with activities. To ensure student participation and minimise AT dominance during RiTe, icebreakers, discussion of expectations and dividing tasks among group members (e.g. assigned group roles such as timekeeper or group leader) are used to promote group cohesion and to reduce social loafing (putting in less effort in group settings) (Meyers, 1997; Jackson & Williams, 1985). Harkin & Petty (1982) suggested that social loafing can be reduced by increasing the task difficulty (see **Paper 5**), but also by making everyone in the group responsible for a different task (see **Paper 1,** p356 The RiTe project pilot). Face-to-face contact time with ATs is reduced with RiTe because of CEBL and so could potentially be viewed as a negative student experience, resulting in decreased student satisfaction (Dean & Gibbs, 2015; Blair, 2017) although was not identified in my research.

Other issues were attributed to the student understanding of research processes which has also been identified by Imafauku *et al.,* (2015). For example, performing statistical data analysis within RiTe required additional teaching support:

> "*None of us could remember how to put standard deviation bars on [Excel], we all knew what they were, but we couldn't remember how to do it*…"
>
> **(**Higgins *et al*., 2013a)

Consideration also needs to be given to group size and this was an important factor for both students and ATs regarding learning and group participation in OPTIMAX (Higgins *et al.,* 2014b). Although smaller groups allow greater sharing of tasks, they may contain less diversity and lack divergent thinking. Similarly, with larger groups it is difficult to ensure that all members of the team participate with all activities (Jacques & Salmon, 2007). With RiTe students attend in groups of approximately 12 students per group and are then divided into 2 smaller CEBL groups to ensure active participation and sharing of tasks throughout the group.

6.2 Wider contributions of the publications

RiTe and OPTIMAX have been cited as innovative case studies by the Council of Deans of Health linking research and teaching in pre-registration curricula for allied health courses (see https://councilofdeans.org.uk/case-study/research-informed-teaching-experience-rite-in-bsc-diagnostic-radiography-curriculum/ and https://councilofdeans.org.uk/wp-content/uploads/2019/05/CODH.RIPR_.report_v3-002.pdf). Students have also disseminated their research at major conferences following RiTe and OPTIMAX adding further to the body of knowledge with medical imaging research. When designing RiT activities that are multi-cultural and/or multi-professional, cultural differences in communication do not necessarily

seem to be the main threat to successful learning and interaction, indeed CEBL can have a positive effect:

> *"You gain some new knowledge especially from your colleagues and from the students also. People from different cultures and professions have their own approach to research, that is quite different from our approach and you can learn from them."*

> *"I learnt a lot from peers in my team, because we are all at different [academic] levels, so it was great to meet with all of them and share ideas and ways of learning."*
>
> (Higgins *et al.*, 2014b)

However, potential problems can arise from failing to provide proper guidance and allocation of formal roles within the group to encourage support during challenging times. During OPTIMAX it was identified that leading successful group learning does not always come naturally to many ATs who may fall back on a reserve position of authority. Skills in facilitating a clear and co-ordinated strategy, are important factors for effective team working and learning and recommendations have been integrated into subsequent versions of OPTIMAX following research by Robinson *et al*., (2014) and Higgins *et al.,* (2014b) to ensure that there are two ATs per group to help facilitate CEBL group working and a student-centred approach to learning.

Expanding RiT is now seen a key component of the Research and Knowledge Exchange Strategy within the UoS, and consequently there is intention to extend RiT across the University into other discipline areas. RiTe and OPTIMAX within the UoS are perceived as excellent examples of how to achieve and embed RiT within the undergraduate curriculum to support leaning and research skills development and have generated interest by other healthcare academics internal and external to University wanting to use RiT. However, another driver for

RiT as discussed in Chapter 2 lies with the REF and TEF. Regardless of the research intensity of the institution, HEIs that can demonstrate how they have embedded RiT into their curriculum are more likely to receive an award above the standard of their metrics (bronze award) (Office for Students, 2018b).

Chapter Seven: Conclusion, recommendations, limitations and further work

7.1 Conclusion

There is an absence of studies that have explored RiT within the undergraduate Diagnostic Radiography curricula. RiTe has built research into the core curriculum for the BSc (Hons) Diagnostic Radiography course at the UoS and provides opportunities for students to be engaged with research from year 1 onwards. This culminates with a research dissertation in year 3 that acts as a capstone project to ensure that they can demonstrate the research skills and knowledge gained. The publications in this thesis explored the student learning experience of RiTe and OPTIMAX as RiT models for undergraduate learning and research skills development using CEBL. Based on qualitative and quantitative analysis it can be concluded that both RiTe and OPTIMAX are seen by students as being valuable, relevant and interesting teaching and learning activities. Findings indicated that one key element of the success of RiTe and OPTIMAX was that of CEBL and students being able to share knowledge and experiences. However, FG research did identify that students felt that they could not apply or share with qualified practitioners what they learned following RiTe, but this might be less of an issue following post-qualification. Although questionnaire research (**Paper 4**) did not identify this as an issue with the wider year 1 cohort.

The publications in this thesis have provided new insights into using RiT with CEBL to develop student research skills and support learning. This model could potentially be applied across other disciplines to help immerse students in relevant disciplinary research via a process of collaboration and enquiry and help to embed RiT into curricula. This may also help to support TEF submissions by HEIs and the attainment of a silver or gold award. Challenges and issues have been also highlighted to provide information on the complexity of designing and

implementing RiT activities such as RiTe or OPTIMAX and potential barriers to students applying research skills or knowledge. By analysing the student experience of RiTe and OPTIMAX using the NWKM, the publications in this thesis have also shown the importance of student evaluation and how learning activities that are liked by students are an important proxy for learning and development.

7.2 Recommendations

The publications in this thesis have shown how research linked with teaching can be embedded within an undergraduate curriculum. Based on this research recommendations are suggested for other HEIs who may wish to develop undergraduate or postgraduate student research skills or link teaching with research within their disciplines. These include:

- Consider using RiT to develop research skills in undergraduate or postgraduate students. Any RiT activity should directly link to the students' discipline and practice. This will help students appreciate the role of research and develop key skills needed as part of their future employment within their discipline (linking theory with practice);

- It is important to thoroughly evaluate both the student and teacher experience to determine if outcomes match expectations and whether it is seen to be engaging and effective (for example using the NWKM model). Learning outcomes should be demonstrable and constructively aligned to the appropriate year of academic study on the course;

- Consider using student centred or collaborative enquiry-based leaning approaches with RiT. This helps students to share knowledge and experience and promotes key

employability skills such as team working. This also mirrors real world research practices. However, consideration needs to be given to group working and learning processes. Group size and allocation of group roles are an important factor for both learning and group participation. Small group sizes may lack divergent thinking and bigger group sizes limit the sharing of tasks.

7.3 Limitations

The data analysis for each publication was reliant on my interpretation as a solo researcher. This therefore may have affected the trustworthiness of the analysis of the qualitative data. The use of more than one person to interpret my data or the use of member checking may have minimised any researcher bias and further established trustworthiness with my publications (Birt *et al*., 2016; Anney, 2014). However, some authors caution against the uncritical use of member checking (e.g., Barbour, 2001). A literature review performed by Thomas (2016) did not find any evidence that routine member checking enhanced the credibility or trustworthiness of qualitative research, especially if the primary focus was on theory development and generalisation. Common problems identified by Thomas (2016) with member checking also included; a lack of response from most participants, creating additional intrusion for participants, little or no substantive changes in research findings, and the need for additional research resources.

Given the potential for the students to perceive me as being in a position of power as an AT and facilitator for RiTe (**Paper 2** onwards), it is unknown if all the questionnaire and FG responses were answered honestly. All the participants knew me and might have therefore felt they needed to say what they thought I wanted to hear rather than what they truly felt. There may also have been some potential skew with the selection of FG participants as those with a more active

interest in research may been more likely to have volunteered (Drennan & Goodman, 2011). FG discussion is also dependant on the dynamics of the participants; for example, if participants are uneasy with one another they may not discuss their feelings and opinions freely or hesitate to participate in the topic of interest which can affect the data collection (Nyumba *et al*., 2018). However, this was not something that was apparent during my research. Although FGs capture the thoughts of several participants at the same time, they do limit in-depth responses that may have been obtained by one-to-one interviews (Strauss & Corbin, 1990). As I was more interested in gathering a multiplicity of views with RiTe and OPTIMAX as a group learning experience, I was not concerned by this limitation. Nonetheless, an issue for the FG moderator (and for analysis), is how to deal with one or several group member(s) dominating the discussion so that theirs is the only opinion clearly articulated which could then potentially be represented as the 'group's opinion' (Smithson, 2000). During my FG research I attempted to overcome this issue by ensuring that every participant was given the opportunity to share their thoughts and views.

The questionnaire design was informed by themes identified from my FG research which were then turned into questionnaire items. Each questionnaire was piloted to determine clarity, appropriateness and content validity (Mcleod *et al*., 2000). Questionnaire validity was also ensured, by reverse-wording some of the closed choice items to minimise acquiescence bias (Altermatt, 2006). However, the validity and reliability of my questionnaires could have been further assured by identifying whether a validated questionnaire existed that I could have used for this purpose or by using a panel of experts to review my questionnaire items prior to piloting and data collection. Cronbach alpha, or factor analysis could have also been used to validate and ensure reliability of my questionnaire items (Sullivan *et al.*, 2013; Boynton, 2004).

The focus of these publications is with undergraduate students and not graduates who could have provided data on the impact of RiTe in practice. This is an area intended for further work. For **Paper 3** consideration also needs to be given to the multi-cultural and multi-professional diversity of the participants involved with this research.

7.4 Further work

Further development of RiTe could include student conferences and exhibitions within the University (Higgins *et al*., 2013b). Further research is needed to explore student learning outcomes and behaviour towards being able to apply what they have learnt following RiTe. Ongoing research is currently being undertaken to develop and validate a psychometric scale to determine task value and student self-efficacy with RiTe in years 1 and 2 with research skills development. This research builds on the existing publications by exploring level 2 (Learning) of the NWKM. Further work is also needed to better understand whether research activitiy is continued beyond registration following RiTe (NWKM levels 3 (Behaviour) & 4 (Results)).

FG research identified that students felt that they could not apply or share with qualified practitioners what they learned following RiTe, but this might be less of an issue once qualified. Although this was not identified with the wider year 1 cohort, this is still an area that warrants further investigation and could link with broader research exploring influencers and barriers to research in the transition period from student to qualified practitioner.

Chapter Eight: Reflexivity

Overview

This chapter explores the challenges in writing this thesis. Reflexivity is discussed along with a retrospective that explores how my processes and influences may have affected the research outcomes in this thesis.

8.1 Challenges of writing this thesis

This thesis completes a retrospective review of my six publications. At the time of writing my first three publications I had no intention of completing a PhD by Published Work and did not, at the onset, formally establish my research paradigm, rather the decision was made to use a qualitative research method to gather my data as I wanted to explore the student experience of RiTe and OPTIMAX from the participant perspective and investigate the group-shared realities of these. In writing this thesis I have had to work backwards with my publications in determining the approach that I took and the theoretical framework that represented the positioning of these publications within the general body of knowledge.

Prior to commencing the publications in this thesis, I had worked in a scientific research field, but had no experience of qualitative research. I did not keep a reflective diary to provide an 'audit trail' with my qualitative publications as outlined by authors such as Gilgun (2010) to ensure trustworthiness as I was unfamiliar with this process. As an individual I have never kept a diary, nor recorded my thoughts and feelings. I find the concept of keeping a reflective diary personally challenging as discussing my own personal feelings with those outside my immediate family is not something, I am comfortable with. Despite this I have come to realise that reflecting on the research process would have helped me to assess my motives and biases during my research. Therefore, I do plan to try and use a reflective journal to record my

experiences, opinions and thoughts as part of my post-doctoral research to provide greater transparency of my research processes. I did keep field and observational notes at key events such as the FG interviews and recorded key discussion points with my supervisors in my meeting notes as my research progressed so I could go back and review these.

8.2 Reflexivity

Reflexivity provides transparent information to the reader about the positionality and personal values of the researcher that could potentially affect data collection and analysis (Walker *et al*., 2013). A working definition of reflexivity by Gilgun (2010) is the idea that researchers are aware of the multiple influences they have on the research process and how the research process also affects them. Using reflexivity as a self-awareness process during research helps to explore the dynamics of the relationship between the researcher and participants (Finlay & Gough 2003; Powers & Knapp, 2006). This may involve a personal reflection on how the research process influenced and changed the stance taken by the researcher and locates the researcher firmly within the dynamic of the research process and I have attempted to retrospectively explore my research journey in Appendix 9.

During the analysing process, human mistakes are always possible, and mistakes could have been caused by fatigue, errors with interpretation and my own personal bias (Morse & Richards, 2002). When analysing data, the researcher may naturally look for data that confirms their hypotheses or personal experience, overlooking data inconsistent with personal beliefs (Smith & Noble, 2017). I did not use member checking or have someone external to my research to help with interpreting the data which may have impacted upon the trustworthiness of my analysis (Graneheim & Lundman, 2004). Nonetheless, I did consult with my supervisors / co-authors whether the categories or themes were sufficiently clear and comprehensive during my

research. As discussed in Chapter Seven there are critics of member checking who suggest that there is little evidence to suggest that member checking actually improves the final research findings and that respondents could potentially deny or alter what they have said. Also, in the end it is the researcher who conducts the final validation (Thomas, 2017; Murphy & Yielder, 2010). However, I do plan in the future to have my data checked by a third party to help increase trustworthiness of my data analysis (Birt *et al*., 2016; Murphy & Yielder, 2010).

I could have increased the trustworthiness of my questionnaire design by reading about questionnaire design in more detail prior to administering the questionnaire in my research – for example, I could have conducted a literature search to identify whether a validated questionnaire existed that I could have used for this purpose or used a panel of experts to review my questionnaire items prior to piloting and data collection. The psychometric scale in Appendix 2 is based upon my research findings and appropriate germane literature. Despite conducting a literature search I could not identify an appropriate scale to use, but validity and reliability has been assured by using an expert FG panel to review the scale items. The scale was then disseminated to a different FG for piloting to ensure the appropriate wording and understanding of scale items prior to sampling (Krupinski, 2011). Data will be being collected over successive cohorts of year 1 and year 2 students to fully validate the scale with the aim of achieving a sample size of 100-200 participants as recommended by Spector (1992). The scale also consists of an equal number of positively worded and negatively-worded items with the purpose of not necessarily trying to prevent acquiescent responses by participants, but to identify and therefore and control for it.

8.3 Final thoughts

During my journey as both researcher and teacher, I have now come to understand that evaluating how students engage with learning activities is very important. By exploring the different perspectives and experiences by students towards teaching and learning activities, this will help influence the way in which I plan, organise and deliver activities. By undertaking this research, it has also helped me to understand the process of learning by students and the nature of the relationship between the student and teaching (*the learners' world*). By reflecting on my practice as a teacher this will not only benefit my professional growth, but also improve the support I provide to my students by increasing the quality of my teaching.

I have not only gained knowledge and experience of data capture and analysis using quantitative and qualitative methods during my research journey, but it has also helped me to understand how my own thoughts and feelings can potentially impact upon the research process. Arthur in Milligan (2016) argues that a researcher's identity can shift dependent on the situation or by responding to the social, political and cultural values of a given context or moment. At the beginning of my research journey as a practicing radiographer, I viewed myself as a neutral 'outsider' to the students as I was not a member of the academic team. However, once I had become an AT and facilitator for RiTe, I became a 'knowledgeable insider' and this may have shaped the interactions between myself and the participants as I was no longer an outsider to the University (Milligan, 2016). Due to this shift in my relationship with the students I am aware that they might have felt obliged to participate with my research. To try and overcome this, recruitment was undertaken by circulating an information leaflet and participants were asked to complete a form if they wished to take part with the FG and could withdraw at any point. Questionnaires were completed anonymously so that participants could easily abstain if they wished. During the FGs, I used a semi-structured interview technique and did not express

my opinions or views to try and reduce the possibility of these overriding those of the participants. However, I did make a note of these views in my field notes and explored some of these further with the participants as part of the closing session if I felt this warranted exploration. The concept of peer debriefing also enhances trustworthiness by either presenting or publishing initial findings, conference attendance or critical discussion with knowledgeable third parties (Long et al. in Murphy & Yielder, 2010). I have disseminated my work via both peer and non-peer reviewed publications and discussed my findings and observations at conferences or invited workshops (see Appendix 10).

My research has also added to my own understanding of RiT and CEBL which in turn has influenced the development of RiTe to ensure that there is a continued collaboration between students, ATs and CPEs. After talking to CPEs about areas students find difficult to link theory with clinical practice the use and non-use of anti-scatter grids with chest and pelvis phantom image quality and dose optimisation and has been incorporated into RiTe for year 2 students to research. I have also started to consider alternative approaches to RiTe, including a qualitative research component, which could teach students reflexivity skills. Currently qualitative research is taught via a critical appraisal of a qualitative research article in year 2 and in year 3 students have the option to submit a qualitative research proposal or undertake an experimental research project. Therefore, students with an interest in qualitative research are not provided with any real hands on experience to link theory with practice in undertaking or analysing qualitative data unlike their quantitative counterparts which may currently be a limiting factor with RiTe.

The publications in this thesis are timely as there is great interest in exposing undergraduate students to research content during their time at University. Similarly, there is a move towards

developing a research culture and expanding radiography research capacity (SCoR, 2015). My publications have generated interest in developing a research culture within the radiography undergraduate learning curricular with an invited editorial (Higgins *et al.,* 2015) and interest from other healthcare academics both within the UoS and externally looking to start creating RiT experiences for their own students.

References

Ajjaw, R. & Higgs, J. (2007) 'Using hermeneutic phenomenology to investigate how experienced practitioners learn to communicate clinical reasoning'. *The Qualitative Report*, **12**(4): 612-638.

Alermatt, B. (2006) *Questionnaire and Survey Design: Questionnaire Design*. Retrieved 20 January 2018 from: https://psych.hanover.edu/classes/ResearchMethods/Readings/Questionnaire_Design.pdf.

Amankwaa, L. (2016) 'Creating protocols for trustworthiness in qualitative research'. *Journal of Cultural Diversity*, **23**(3): 121-127.

Anney, V.N. (2014) 'Ensuring the Quality of the Findings of Qualitative Research: Looking at Trustworthiness Criteria'. *Journal of Emerging Trends in Educational Research and Policy Studies*, **5**(2): 272-281.

Al Qaroot, B.S. & Sobuh, M. (2016) 'Does integrating research into the prosthetics and orthotics undergraduate curriculum enhance students' clinical practice? An interview study on students' perception'. *Prosthetics and Orthotics International,* **40**(3): 357-362.

Armitage, A. (2007) 'Mutual Research Designs: Redefining Mixed Methods Research Design'. Paper presented at the British Educational Research Association Annual Conference, Institute of Education, University of London, 5-8 September 2007.

Aston L, & Hallam P. (2014) *Successful Mentoring in Nursing*. 2nd ed. London: Sage Publications.

Aziz, S., Mahmood, M. & Rehman, Z. (2018) 'Implementation of CIPP model for quality evaluation at school level: A case study'. *Journal of Education and Educational Development*. **5**(1): 189-206.

Bandura, A. (1997) *Self-efficacy: The exercise of control*. Freeman and Company: New York.

Barbour, R.S. (2001) 'Checklists for improving rigour in qualitative research: a case of the tail wagging the dog?'. *British Medical Journal*, 322: 1115–7.

Bauer, K.W. & Bennett, J.S. (2003) 'Alumni Perceptions Used to Assess Undergraduate Research Experience'. *The Journal of Higher Education*, **74**(2): 210-230.

Bengtsson, M. (2016) 'How to plan and perform a qualitative study using content analysis'. NursingPlus Open, **2**: 8-14.

Biggs, J. (1999) Teaching for Quality Learning at University: What the Student Does. The Society for Research into Higher Education and Open University Press.

Biggs, J. (1991). 'Teaching for Better Learning'. *Legal Education Review*, **2**(1), Article 8.

Birt, L., Scott. S., Cavers, D., Campbell, C. & Walter, F. (2016) 'Member checking: A Tool to Enhance Trustworthiness or Merely a Nod to Validation?' *Qualitative Health Research,* **26**(13): 1802-1811.

Blair, A. (2017) 'Understanding first-year students' transition to university: A pilot study with implications for student engagement, assessment, and feedback'. *Politics,* **37**(2)215-228.

Boswell, S.S. (2013) 'Undergraduates' perceived knowledge, self-efficacy, and interest in social science research'. *The Journal of Effective Teaching*, **13**(2): 48-57.

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

Boyer, E.L. (1990) *Scholarship Reconsidered: Priorities of the Professoriate*. New York: The Carnegie Foundation for the Advancement of Teaching.

Boyer Commission on Educating Undergraduates in the Research University. (1998) *Reinventing undergraduate education: a blueprint for America's research universities*. New York, USA: State University of New York–Stony Brook.

Boynton, P.M. (2004) 'Selecting, designing, and developing your questionnaire'. *British Medical Journa*l, **328**(7451): 1312–1315.

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

Brew, A. (2010) 'Teaching and Research: New relationships and their implications for inquiry-based teaching and learning in higher education'. *Higher Education Research and Development*, **22**(1): 3-18.

Brew, A. (2006) *Research and teaching: Beyond the divide.* Hampshire: Palgrave Macmillan.

Brew, A. & Boud, D. (1995) 'Teaching and research: Establishing the vital link with learning'. *Higher Education*, **29**(3): 261-273.

Brown, S.C., Stevens, Jr. R.A., Troiano, P.F. & Schneider M.K. (2002) 'Exploring complex phenomena: Grounded theory in student affairs research'. *Journal of College Student Development;* March/April: **43**(2): 1-11.

Buckley, J.A., Korkmaz, A., & Kuh, G.D. (2008) 'The disciplinary effects of undergraduate research experiences with faculty on selected student self-reported gains'. *Annual Meeting of the Association for the Student of Higher Education,* p: 6–8. Citeseer.

Buckley, C.A. (2011) 'Student and staff perceptions of the Research-Teaching Nexus'. Innovations in Education and Teaching International, 313-322.

Bungay, H., Gibson, S., Gibbs, J. Denton, R. & Springett, K. (2010) 'The Influence of the Personal Tutor in Supporting Students with Specific Reference to Attrition'. In *Research Informed Teaching: Exploring the Concept*, edited by L. Graham-Matheson, 42–43. Canterbury: Canterbury Christ Church University.

Caillaud, S. & Flick, U. (2017) Focus groups in triangulation contexts. In R. Barbour & D. Morgan (Eds) *Advances in Focus Groups Research*. Hampshire: Palgrave Macmillan.

Carini, R.M., Kuk, G.D. & Klein, S.P. (2006) 'Student engagement and student learning: Testing the Linkages'. *Research in Higher Education*, **47**(1): 1-32.

Carr, H. & Dearden, N. (2012) 'Research-led Teaching, Vehicular Ideas and the Feminist Judgments Project'. *Law Teache*r, **46**(3): 268-280.

Castleberry, A & Nolen, A. (2018) 'Thematic analysis of qualitative research data: Is it as easy as it sounds?'. *Currents in Pharmacy Teaching and Learning*, **10**(6): 807-815.

Centre for Learning and Academic Development [CLAD] (2012) *Research Informed Teaching at the University of Birmingham. Final Project Report. Birmingham*, UK: CLAD, University of Birmingham.

Chapman, A.L., Hadfield, M. & Chapman, C.J. (2015) 'Qualitative research in healthcare: An introduction to grounded theory using thematic analysis'. *The Journal of the Royal College of Physicians of Edinburgh*, **45**(3): 201-205.

Chu, K.W., Tseb, S.K. & Chow, K. (2011) 'Using collaborative teaching and inquiry project-based learning to help primary school students develop information literacy and information'. *Library & Information Science Research*, **33**(2): 132-143.

Chu, S. (2009) 'Inquiry project-based learning with a partnership of three types of teachers and the school librarian'. *Journal of the American Society for Information Science and Technology*, **60**: 1671-1686.

Cleaver E., Lintern, M. & McLinden M. (2014) *Teaching and Learning in Higher Education: Disciplinary Approaches to Educational Enquiry*. London, UK: Sage.

Cohen, E.G. (1994) Restructuring the classroom: conditions for productive small groups. *Review of Educational Research*, 64: 1-35.

Cook, D.A. (2010) 'Twelve tips for evaluating educational programs'. *Medical Teacher*, **32**(4): 296-301.

Creswell, J.W. (2015) *A Concise Introduction to Mixed Methods Research*. London: Sage Publications.

Creswell, J.W. & Plano Clark, V.L. (2011) *Designing and Conducting Mixed Methods Research.* 2nd Edition. Thousand Oaks: Sage Publications.

Dean, A. & Gibbs, P. (2015) 'Student satisfaction or happiness?: A preliminary rethink of what is important in the student experience*". Quality Assurance in Education*, **23**(1): 5-19.

Denscombe, M. (1999) *The Good Research Guide for Small-Scale Social Research Projects*. Buckingham: Open University Press.

Department for Business, Energy and Industrial Strategy. (2016) *Building on Success and Learning from Experience*. (Stern Review). Retrieved 19 August 2019 from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/541338/ind-16-9-ref-stern-review.pdf.

Department for Business Innovation and Skills. (2016) *Success as a Knowledge Economy: Teaching Excellence, Social Mobility and Student Choice*. Retrieved 1 December 2017 from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/523546/bis-16-265-success-as-a-knowledge-economy-web.pdf.

DeVellis, R.F. (1991) *Scale Development: Theory and Applications (Applied Social Research Methods Series, Vol. 26).* Newbury Park, CA: Sage Publications.

Dillenbourg, P. (1999) What do you mean by collaborative learning? In: Dillenbourg P (ed) Collaborative-learning: cognitive and computational approaches. Oxford: Elsevier pp 1–19.

Dochy, F., Segers, M., Van den Bossche, P., & Gijbels, D. (2003) 'Effects of problem-based learning: a meta-analysis'. *Learning and Instruction*, **13**: 533-568.

Domenech-Betoret, F., Abellan-Rosello, L. & Gomez-Artiga, A. (2017) 'Self-Efficacy, Satisfaction, and Academic Achievement: The Mediator Role of Students' Expectancy-Value Beliefs'. *Frontiers in Psychology*, 8:1193. doi: 10.3389/fpsyg.2017.01193.

Dong, J. & Guo, H. (2013) *Effective collaborative inquiry-based learning in undergraduate computer networking curriculum*. Proceedings of the 2013 American Society for Engineering Education (ASEE) Annual Conference. Atlanta, USA.

Drennan, V. & Goodman, C. (2011) 'Sustaining innovation in the health care workforce: a case study of community nurse consultant posts in England'. *BMC Health Services Research*, **11**(200): 1-10.

Eccles, J.S., Adler, T.F. with the assistance of, Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L. & Midgley, C. (1983) *Expectancies, values and academic behaviors*. In Spence, J.T. (Ed), Achievement and achievement motives (p75-146). San Francisco: W.H. Freeman.

Elton, L. (2006) 'The nature of effective or exemplary teaching in an environment that emphasizes strong research and teaching links'. *New Directions for Teaching and Learning*, 107: 33-41.

Finlay, L. & Gough, B. (2003) *Reflexivity: A practical guide for qualitative researchers.* Oxford: Blackwell.

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

Gandomkar, R. (2017) 'Comparing Kirkpatrick's original and new model with CIPP evaluation model'. Journal of Advanced of Medical Education and Professionalism, **6**(2): 94-95.

Garland, D.R., O'Connor, M.K, Wolfer, M.K. & Netting, F.E. (2006) 'Team-based research: Notes from the field'. *Qualitative Social Work*, **51**(1): 93-103.

Gilgun, J.F. (2010) Reflexivity in Qualitative Research. *Current Issues in Qualitative Research Book,* 1(2).

Glasgow Caledonian University (no date). Literature search strategy template. Retrieved 4 March 2019 from: https://www.gcu.ac.uk/library/.../Literature%20search%20strategy%20template.docx.

Goodyear, P. & Zenios, M. (2007) 'Discussion, collaborative knowledge work and epistemic fluency'. *British Journal of Educational Studies*, **55**(4): 351–68.

Grabinger, R.S. & Dunlap, J.C. (1995) 'Rich Environments for Active Learning: A Definition'. *Association for Learning Technology Journal*, **3**(2): 5-34.

Gray, D.E. (2014) *Doing Research in the Real World*. Third Edition. London: Sage Publications.

Graneheim, U.H. & Lundma, B. (2004) 'Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness'. Nurse Education Today, **24**(2): 105-112.

Grant, K. & Wakelin, S.J. (2009) 'Re-conceptualising the concept of a nexus? A survey of 12 Scottish IS/IM academics' perceptions of a nexus between teaching, research, scholarship and consultancy'. *Teaching in Higher Education*, **14**(2): 133-146.

Griffiths, R. (2004) 'Knowledge Production and the Research-teaching Nexus: The Case of The Built Environment Disciplines'. *Studies in Higher Education*, **29** (6): 709–726.

Guba, E. (1990) *The Paradigm Dialog*. California: Sage.

Guest, G., MacQueen, K.M. & Namey, E.E. (2011) Introduction to applied thematic analysis. In *Applied Thematic Analysis*. Thousand Oaks, CA: Sage.

Harada, V.H. & Yoshina, J.M. (2004) Inquiry learning through librarian–teacher partnerships. Linworth Publishing: Worthington, OH.

Harris, R. & Beardmore, C. (2009) 'The research agenda and the role of the therapeutic radiographer: The College of Radiographers perspective'. *Journal of Radiotherapy in Practice*, **8**(2).

Harkin, S.G. & Petty R.E. (1982) 'Effects of task difficulty and task uniqueness on social loafing'. *Journal of Personality and Social Psychology*, 42: 1214-1229.

Haslett, S. (2013) Exploring Links between Research and Teaching in Higher Education. Retrieved 1 August 2017 from https://www.heacademy.ac.uk/knowledge-hub/links-between-research-and-teaching-higher-education.

Healey, M. (2005) 'Linking research and teaching exploring disciplinary spaces and the role of inquiry-based learning', in Barnett, R. (Ed.), *Reshaping the university: new relationships between research, scholarship and teaching*. Maidenhead: McGraw-Hill/Open University Press.

Healey M. & Jenkins A. (2009) *Developing undergraduate research and inquiry*. Retrieved 1st August 2017 from: https://www.heacademy.ac.uk/knowledge-hub/developing-undergraduate-research-and-inquiry.

Heary, C. & Hennessy, E. (2006) 'Focus Groups Versus Individual Interviews with Children: A Comparison of Data'. *The Irish Journal of Psychology*, **27**(1-2): 56-68).

Hemraj-Benny. T. & Beckford, I. (2014) 'Cooperative and Inquiry-Based Learning Utilizing Art-Related Topics: Teaching Chemistry to Community College Nonscience Majors'. *Journal of Chemical Education*, **91**(10): 1618-1622.

Higher Education Academy and University Alliance. (2016) *What does research-informed teaching look like?* Retrieved 1st December 2017 from: https://www.heacademy.ac.uk/knowledge-hub/what-does-research-informed-teaching-look.

Higher Education Funding Council for England [HEFCE]. (2016) *Teaching Excellence Framework: Year two additional guidance*. Bristol: Higher Education Funding Council for England.

Higgins, J.P.T.& Green, S. (editors) (2011) *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Retrieved 4th March 2013 from: www.handbook.cochrane.org.

Higgins, R., Hogg, P. & Robinson, L. (2013a) 'Towards a research informed teaching experience within a diagnostic radiography curriculum: The level 4 (year 1) student holistic experience'. *Radiography*, **19**(1): 62-66.

Higgins, R., Hogg, P. & Robinson, L. (2013b)'Integrating Research-informed Teaching within an Undergraduate Level 4 (year 1) Diagnostic Radiography Curriculum: A Pilot Study'. *Journal of Vocational Education*, **65**(3): 351-368.

Higgins, R., Robinson, L. & Hogg P. (2014a) 'Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: Results from a level 4 (year 1) student cohort'. *Radiography*, **20**(2): 100-106.

Higgins, R., Robinson, L. & Hogg P. (2014b) 'An evaluation of the student and tutor experience of a residential summer school event (OPTIMAX)'. *Radiography*, **20**(4): 363-368.

Higgins, R., Robinson, L. & Hogg P. (2015) 'Invited Editorial: Unlocking Student Research Potential: Toward a Research Culture in Radiography Undergraduate Learning Curricular'. *Journal of Medical Imaging and Radiation Sciences*, **46**, Issue 3, Supplement, Pages S6–S9.

Higgins, R., Hogg, P. & Robinson, L. (2017a) 'Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: A reflection', *Radiography*, 23, S30-36.

Higgins, R., Hogg, P. & Robinson, L. (2017b) 'Research Informed Teaching Experience in Diagnostic Radiography: Perspectives of Academic Tutors and Clinical Placement Educators'. *Journal of Medical Imaging and Radiation Sciences*, **48**(23): 226-232.

Hmelo-Silver, C.E., Duncan, R.G. & Chinn C.A. (2007*) Scaffolding and achievement in problem-based and inquiry learning*: *a response to Kirschner, Sweller,& Clark.*

Hoddinott, J. & Wuetherick, B. (2005) 'The teaching research nexus', *Education Canada*, **46**(1): 32-35.

Horne, M., Woodhead, L., Morgan, L., Smithies, D., Megson, G. & Lyte, G. (2007) Nurse Education Today, **36**(3): 103-112.

Houghton, T. (2016) 'Evaluation of the student learning experience'. *Nursing Standard*, **31**(9): 42-51.

House of Commons, Innovation, Universities, Science and Skills Committee. (2009) 'Students and Universities'. Eleventh Report of Session 2008-2009. London: The Stationary Office Limited.

Hu, S., Kuh, G. & Li, S. (2008) 'The effects of engagement in inquiry-oriented activities on student learning and personal development'. *Innovative Higher Education*, **33**: 71-81.

Hunter, A.B., Laursen, S.L. & Seymour, E. (2007) 'Becoming a scientist: The role of undergraduate research in students' cognitive, personal, and professional development'. *Science Education*, **9**(1): 36-74.

Hutchings, W. (2007) 'Enquiry-Based Learning: Definitions and Rationale'. Retrieved 11th November 2017 from: http://www.ceebl.manchester.ac.uk/resources/papers/hutchings2007_definingebl.pdf.

Imafuku, R., Takuya, S., Kawakami, C. & Suzuki, Y. (2015) 'How do students' perceptions of research and approaches to learning change in undergraduate research?'. International Journal of Medical Education, **6**:47-55.

Kirton, A. Campbell, P & Harwick, L. (2013) *Developing applied research skills through collaboration in extra-academic contexts*. York: The Higher Education Academy.

Kuhlthau, C.C. & Maniotes, L. (2007) *A Caspari Guided inquiry: Learning in the 21st century*. Libraries Unlimited: Westport, CT.

Kuhn, T. S. (1962) *The structure of scientific revolutions.* (1st Edn). Chicago, IL: University of Chicago Press.

James, C. & Roffe, I. (2000) 'The evaluation of goal and goal-free training innovation', *Journal of European Industrial Training*, **24**(1):12-20.

Jackson, J.M. & Williams, K.D. (1985) 'Social loafing on difficult tasks: Working collectively can improve performance'. *Journal of Personality and Social Psychology*, 49: 937-942.

Jackson, A.J.H. (2018) REF, TEF, and KEF; and the "Research-Informed" Teaching and Co-Production Traditions in Local History: Analysing Provincial Newspapers'. *International Journal of Regional and Local History*, **13**(1): 68-85.

Jacques, D. & Salmon, G. (2007) Learning in groups: a handbook for face-to-face and online environments. 4th Edition. Routledge: New York.

Jenkins, A. (2004) *A guide to the research evidence on teaching-research relations*. York: The Higher Education Academy.

Jenkins, A. & Healey, M. (2009) 'Developing the Student as Researcher Through the Curriculum'. CETL Journal: Innovation in Practice, 2(1): 1–15.

Jenkins, A. & Healey, M. (2005) Institutional strategies to link teaching and research. Retrieved 27th October 2017 from: https://www.heacademy.ac.uk/knowledge-hub/institutional-strategies-link-teaching-and-research-full-report.

Jenkins A. & Zetter, R. (2003) *Linking Research and Teaching in Departments,* LTSN Generic Centre, Learning and Teaching Support Network, Oxford Brookes University. Retrieved 27th October 2017 from: http://www.alanjenkins.info/publications/PF_Jan_07_Martyn_Stewart_RIT.pdf.

Jenkins A., Healey, M. & Zetter, R. (2007) *Linking Research and Teaching in Disciplines and Departments*. York: HE Academy.

Johnson, D.W. & Johnson, R. (1989) *Cooperation and competition: Theory and researc*h. Minneapolis: Interaction Book Company.

Johnson, D., Johnson, R. & Holubec, E. (1992) *Cooperation in the classroom*. Minneapoli**s:** Interaction Book Company.

Khan, P. & O'Rouke, K. (2004) 'Guide to Curriculum Design: Enquiry-Based Learning'. Retrieved 11th November 2017 from: http://www.ceebl.manchester.ac.uk/resources/guides/kahn_2004.pdf.

Kivunja, C. & Kuyini, A.B (2017) 'Understanding and Applying Research Paradigms in Educational Contexts'. *International Journal of Higher Education*, **6**(5): 26-41.

King, N. (2004) Using templates in the thematic analysis of text. In C. Cassell & G. Symon (Eds*.), Essential guide to qualitative methods in organizational research* (pp. 257–270). London, UK: Sage.

Kirkpatrick, D.L. (1967) Evaluation of training. In Craig, R., Bittel, L., Eds. *Training and Development Handbook*. New York, NY: McGraw-Hill; 87-112.

Kirkpatrick, D.L. (1959) 'Techniques for evaluating training programmes'. *Journal of the American Society of Training Directors*, 13: 21-26.

Kirkpatrick J.D. & Kirkpatrick W.K. (2016) *Kirkpatrick's four levels of training evaluatio*n. Alexandria (VA): ATD Press.

Kirkpatrick, J.D. & Kirkpatrick, W.K. (2009) Kirkpatrick, Then and Now: A Strong Foundation for the Future. St Louis, MO: Kirkpatrick Partners.

Kirkpatrick Partners. (2015) 'The New World Kirkpatrick Model'. Retrieved 31st January 2019 from https://www.kirkpatrickpartners.com/Our-Philosophy/The-New-World-Kirkpatrick-Model.

Kitching, J.J., Cassidy, S.F., Eachus, P. & Hogg, P. (2011) 'The Role of Perception in Imaging: Past and Future'. *Radiologic Technology*, **83**(1): 10-19.

Krunpinski, E.A. (2011) 'Creating and validating self-efficacy scales for students'. *Seminars in Nuclear Medicine*, **41**(6): 392-400.

Krause, K-L. & Coates, H. (2008) 'Students' engagement in first-year university'. *Assessment and Evaluation in Higher Education*, **33**(5): 493-505.

Laal, M. & Ghodsi, S.M. (2012) 'Benefits of collaborative learning'. *Procedia - Social and Behavioral Sciences*, **31**: 486-490.

Lather, P. (1986)' Research as praxis'. *Harvard Educational Review*, **56**(3): 257-277.

Lane, N. (1996) Workshop on NSF recognition awards for integrating research and education. Washington, DC. Retrieved 27th October 2017 from: http://www.nsf.gov/news/speeches/lane/nlr_efnd.htm

Lather, P. (2006) 'Paradigm proliferation as a good thing to think with: Teaching research in education as a wild profusion'. International Journal of Qualitative Studies Education, 19(1), January-February: 35-57.

Laursen, S., Hunter, A. B., Seymour, E. Thiry, H. & Melton, G. (2010) *Undergraduate research in the sciences: Engaging students in real science.* San Franciso, CA: Jossey-Bass.

Levy, P. & Petrulis, R. (2011) 'How do first-year university students experience inquiry and research, and what are the implications for the practice of inquiry-based learning?'. *Studies in Higher Education*, **37**(1): 85-101.

Lin, L. (2015) Investigating Chinese HE EFL Classrooms: Using Collaborative Learning to Enhance Learning. Switzerland: Springer-Verlag Berlin Heidelberg.

Lincoln, Y. & Guba, E. (1985) *Naturalistic inquiry*. London: Sage.

Mackenzie, N. & Knipe, S. (2006) 'Research dilemmas: Paradigms, methods and methodology'. *Issues In Educational Research*, 16, 2006. Retrieved 21st December 2017 from: http://www.iier.org.au/iier16/mackenzie.html.

Manning-Stanley, A. (2017) 'Radiography research'. *Imaging and Therapy Practice*, March, 13-17.

Mawer, M. (2014) *A study of research methodology used in evaluations of international scholarship schemes for higher education*. The Commonwealth Scholarship Commission in the United Kingdom, London. UK.

Mavin, S., Lee, L. & Robson, F. (2010) 'The evaluation of learning and development in the workplace: a review of the literature'. Retrieved 12th October 2018 from: http://www.northumbria.ac.uk/static/5007/hrpdf/hefce/hefce_litreview.pdf.

McKim, C.A. (2017) 'The Value of Mixed Methods Research: A Mixed Methods Study'. *Journal of Mixed Methods Research*, **11**(2): 202–222/

McLeod, P.J., Meagher, T.W., Steinert, Y. & Boudreau, D. (2000) 'Using focus groups to design a valid questionnaire, educating physicians: essays'. *Academic Medicine*. **57**(6), June: 671.

McLinden, M., Edwards, C., Garfield, J. & Morn-Garcia, S. (2015) 'Strengthening the Links Between Research and Teaching: Cultivating Student Expectations'. *Education in Practice*, **2**(1): 24-29.

Meyers, A.A. (1997) 'Increasing student participation and productivity in small-group activities for psychology classes'. *Teaching of Psychology*, 24: 105-115.

Milligan, L. (2016) 'Insider-outsider-inbetweener? Researcher positioning, participative methods and crosscultural educational research'. *Compare: A Journal of Comparative and International Education*, **46**(2): 235-250.

Milojevic, S. (2014) 'Principles of scientific research team formation and evolution'. *Proceedings of the National Academy of Sciences of the United States of America*, **111**(11): 3984-3989.

Moon, J.A. (2004) *A Handbook of Reflective Practice*. New York: Routledge.

Moreau, K.A. (2017) 'Has the new Kirkpatrick generation built a better hammer for our evaluation toolbox?'. *Medical Teacher*, **39**(9): 999-1001.

Morse, J., & Richards, L. (2002) Coding. In J. Morse & Richards (Eds.), *Read me first for a user's guide to qualitative methods* (pp. 111–128). Thousand Oaks, CA: Sage.

Morgan, D. (2007) 'Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods'. *Journal of Mixed Methods Research*, **1**(1): 48-76.

Morse, J.M. & Niehaus, L. (2009) *Mixed method design: principles and procedures. Developing qualitative inquiry*. 4. Walnut Creek, Calif.: Left Coast Press.

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

National Health Service [NHS] Leadership Academy. (2017) *The Elizabeth Garrett Anderson programme.* 'The essence of enquiry: Using different paradigms in research'. NHS Leadership Academy Victoria, London.

NIH Office of Behavioral and Social Sciences. (2018) *Best practices for mixed methods research in the health sciences* (2nd ed). Bethesda: National Institutes of Health.

Nicholson, A. (2017) 'Research-informed teaching: a clinical approach'. *The Law Teacher*, **51**(1): 40-55.

Norton, S., Hogg, P., Higgins, R**.**, Robinson, L., Norton, E., Mackay, S., Newton-Hughes, A., Szczepura, K., Tootell, A., Farell, A., Manning, D. & Qaroot, B.A. (2012) 'Enhancing the learning experience: RiTe II'. *Imaging Therapy and Practice*, 20-23.

Nottingham Trent University. (2013) CADQ Guide: Research informed teaching and enquiry-based learning. March 1-9. Retrieved 10th November 2017 from: www.ntu.ac.uk/cadq.

Nowell, L.S., Norris, J.M., White, D.E & Moules, N.J. (2017) 'Thematic analysis: Striving to meet the trustworthiness criteria'. *International Journal of Qualitative Methods*, **16**: 1-13.

Nulty, D.D. (2008) 'The adequacy of response rates to online and paper surveys: what can be done?'. *Assessment and Evaluation in Higher Education*, **33**(3): 301-314.

Nunamaker, J.F. (1997) 'Future research in group support systems: needs, some questions and possible directions'. *International Journal of Human-Computer Studies*, 47: 357–385.

Nyumba, T.O., Wilson, k., Derrick, C.J. and Mukherjee, N. (2018) 'The use of focus group discussion methodology: Insights from two decades of application in conservation'. Methods in Ecology and Evolution, **9**(1): 20-32.

O'Gorman, K. D., & MacIntosh, R. (2015) Mapping Research Methods. In O'Gorman, K. & MacIntosh, R. (Eds.), *Research Methods for Business and Management* (pp. 50-74). (Global Management Series). Goodfellow Publishers.

Office for Students [OfS]. (2018a) *The Teaching Excellence and Student Outcomes Framework (TEF): A short guide to the 2018 awards*. Retrieved 26th March 2019 from: https://www.officeforstudents.org.uk/advice-and-guidance/teaching/tef-data/

Office for Students [OfS]. (2018b) *TEF data*. Retrieved 22nd April 2018 from: https://www.officeforstudents.org.uk/advice-and-guidance/teaching/tef-data/

Pan, W., Murray, P. & Cotton, D. (2011) *Drivers, Barriers and Strategies for Implementing Research-informed Teaching: A Case Study of the Environmental Building Discipline*. Paper presented at the Proceedings of the International Conference of Engineering Education (ICEE), Belfast, UK, 21-26 August 2011.

Patton, M.Q. (2002) *Qualitative Research & Evaluation Methods* (3rd ed.). Sage Publications, Inc.

Patton, M.Q. (1999) 'Enhancing the quality and credibility of qualitative analysis'. *Health Service Research Journal*. **34**(5 Pt 2):1189-1208.

Paull, M., Whitsed, C. & Girardi, A. (2016) 'Applying the Kirkpatrick model: Evaluating an Interaction for Learning Framework curriculum intervention'. *Issues in Educational Research*, **26**(3): 490-507.

Polit, D.F., & Beck, C.T. (2014). *Essentials of nursing research: Appraising evidence for nursing practice* (8th ed.). Philadelphia, PA: Wolters Kluwer/Lippincott Williams & Wilkins.

Polit, D.F. & Tatano Beck, C. (2010) 'Generalization in quantitative and qualitative research: Myths and strategies. *International Journal of Nursing Studies*, **47**: 1451-1458.

Powers, B.A. & Knapp, T.R. (2006) *Dictionary of nursing theory and research.* 3rd Edition., New York: Springer Pub. Co.

Ramsden, P. (2003) *Learning to Teach in Higher Education*. 2nd Edition, London: RouteledgeFalmer.

Rau, W. & Heyl, B.S. (1990). 'Humanizing the college classroom: Collaborative learning and social organization among students'. *Teaching Sociology* **18**(April): 141-55.

Reeves, P. (2008) 'Research in medical imaging and the role of the consultant radiographer: A discussion'. *Radiography*, **14**: e61-e64.

Reynolds, J., Kizito, J., Ezumah, N., Mangeshao, P., Allen, E & Chandler, C. (2011). 'Quality assurance of qualitative research: A review of the discourse'. *Health Research Policy and Systems*, **9**(43): 1-10.

Robinson, L., Hogg P. & Higgins R. (2014) 'An observational study of cross-cultural communication in short-term, diverse professional learning groups'. *Radiography*, **20**(4): 356-362.

Rossman, G. & Rallis, S. (2012) *Learning in the field: An introduction to qualitative research*. 3rd Edition. Los Angeles: Sage Publications.

Rowbotham, M. & Schmitz, G.S. (2013) 'Development and Validation of a Student Self-Efficacy Scale'. *Journal of Nursing Care*, **2**(126).

Sample, S. (1972) 'Inherent conflict between research and education'. *The Educational Record*, **53**(1), 17-22.

Senaratne, S., Amaratunga, D., Baldry D., Kagioglou, M., Aouad, G. & Bowden, A. (2003) *Research Knowledge Transfer into Teaching in the Built Environment*. Extract from: Education in Changing Environment 17th-18th September 2003 Conference Proceedings. University of Salford.

Shannon-Baker, P. (2016) 'Making Paradigms Meaningful in Mixed Methods Research' *Journal of Mixed Methods Research*, **10**(4): 319–334.

Simons, M. (2006) 'Education through research at European Universities: Notes on the orientation of academic research'. *Journal of Philosophy of Education*, **40**(1): 32-50.

Smith, C. (2017) 'Mind the gap! Students' expectations and early experiences of higher education'. *Innovations in Practice*, 11(1): 23-38.

Smith, J. & Noble, H. (2017) 'Bias in research'. *Evidence Based Nursing*, **17**:100-101.

Smithson, J. (2000) 'Using and analysing focus groups; Limitations and possibilities'. *International Journal of Social Research Methodology*, **3**(2): 103-119.

Society and College of Radiographers [SCoR] (2015) Society and College of Radiographers Research Strategy [2016-2021]. London: SCoR.

Spector, P. (1992) Summated rating scale construction e an introduction. California: Sage Publications.

Spronken-Smith, R.A. (2008) Experiencing the Process of Knowledge Creation: The Nature and Use of Inquiry-Based Learning in Higher Education.

Spronken-Smith, R.A. & Walker, R. (2010) 'Can inquiry-based learning strengthen the links between teaching and disciplinary research?', *Studies in Higher Education,* **35**(6): 723-40.

Stanford, J.S., Rocheleau, S.E., Smith, K.P.W. & Mohan, J. (2017) 'Early Undergraduate Research Experiences Lead to Similar Learning Gains for STEM and Non-STEM Undergraduates'. *Studies in Higher Education,* **42**(1): 115–129.

Strauss, A. & Corbin. J. (1990) Basics of qualitative research techniques and procedures for developing grounded theory. 2nd ed. London: Sage Publications.

Sullivan, G.M. & Artino, A.R. (2013). 'Analyzing and Interpreting Data From Likert-Type Scales' *Journal of Graduate Medical Education*, **5**(4): 541–542.

Taylor, J. (2008) 'The teaching–research nexus and the importance of context: a comparative study of England and Sweden'. *Compare: A Journal of Comparative and International Education*, **38**(1): 53-69.

Teddlie, C. & Tashakkori, A. (2009) *Foundations of Mixed Methods Research: Integrating Qualitative and Quantitative Approaches in the Social and Behavioral Sciences*. Thousand Oaks, CA: Sage Publications.

Temple, P., Callender, C., Grove, L. & Kersh, N. (2014) *Managing the student experience in a shifting higher education landscape*. York: The Higher Education Academy.

The Political Studies Association. (2016) TEF Bulletin. Retrieved 6th October 2017 from: https://www.psa.ac.uk/sites/default/files/TEF%20Bulletin.pdf.

Tight, M. (2012) Research in Higher Education, 2nd ed. Berkshire, England: Open University Press/McGraw-Hill Education.

Thomas, D.R. (2017) 'Feedback from research participants: are member checks useful in qualitative research?'. *Journal Qualitative Research in Psychology*, **24**(1): 23-41.

Tosey, P. & McDonnell, J. (2006) *Mapping Enquiry-Based Learning. Discourse, Fractals and a Bowl of Cherries*. Learning to Learn through Support Enquiry (L2L), University of Surrey. Retrieved 12th November 2017 from: http://www.som.surrey.ac.uk/learningtolearn/documents/mappingEBL.pdf.

Trowler, P. & Wareham, T. (2008) Tribes, territories, research and teaching: Enhancing the teaching-research nexus. York: The Higher Education Academy.

Walker, S., Read, S. & Priest H. (2013) 'Use of reflexivity in a mixed-methods study'. *Nurse Researcher*, **20**(3): 38-43.

Webb, N.M. (1982) 'Group Composition, Group Interaction, and Achievement in small groups'. *Journal of Educational Psychology*, **74**(4): 475-484.

Wigfield, A. & Eccles, J.S. (2000) 'Expectancy-value theory of achievement motivation'. Contemporary Educational Psychology, 25: 68-8.

Wilkes, M. & Bligh, J. (1999) 'Evaluating educational interventions'. *British Medical Journal*, **318**:1269-72.

Willison, J. & O'Regan, K. (2007) 'Commonly known, commonly not known, totally unknown: a framework for students becoming researchers'. *Higher Education Research & Development*, **26**(4): 393-409.

Wood, D. & O'Malley, C. (1996) 'Collaborative learning between peers: An overview'. *Educational Psychology in Practice* **11**(4): 4-9.

Villa, E.Q., Kephart, K., Gates, A.Q., Thiry, H. & Hug, S. (2013) 'Affinity research groups in practice: Apprenticing students in research'. *Journal of Engineering*, **102** (3): 444-466.

Vaismoradi, M., Jones, J. Turunen, H. & Snelgrove, S. (2016) 'Theme development in qualitative content analysis and thematic analysis'. *Journal of Nursing Education and Practice*, **6**(5): 100-110.

Von Glasersfeld, E. von (1989) Constructivism in Education. In Husen, T. & Postlewaite, N. (Eds*), International Journal of Educational Management*, **14**(5): 216-223.

Vygotsky, L.S. (1978) *Mind in society: The development of higher mental processes*. Cambridge: Harvard University Press.

Yilmaz, K. (2013)' Comparison of Quantitative and Qualitative Research Traditions: epistemological, theoretical, and methodological differences' *European Journal of Education*, **48**(2): 311-325.

Yin, R.K. (2011). *Qualitative Research from Start to Finish*. New York: The Guilford Press, New York.

Appended publications 1-6

PAPER 1:

INTERGRATING RESEARCH-INFORMED TEACHING WITHIN AN UNDERGRADUATE LEVEL 4 (YEAR 1) DIAGNOSTIC RADIOGRAPHY CURRICULUM: A PILOT STUDY

Integrating research-informed teaching within an undergraduate level 4 (year 1) diagnostic radiography curriculum: a pilot study

Higgins, RN, Hogg, P and Robinson, L 2013, 'Integrating research-informed teaching within an undergraduate level 4 (year 1) diagnostic radiography curriculum: a pilot study' , Journal of Vocational Education & Training, **65** (3) , pp. 351-368.

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Abstract

This article discusses the piloting and evaluation of the Research-informed Teaching experience (RiTe) project. The aim of RiTe was to link teaching and learning with research within an undergraduate diagnostic radiography curriculum. A preliminary pilot study of RiTe was undertaken with a group of level 4 (year 1) volunteer BSc (Hons) diagnostic radiography students to evaluate their experiences. The students undertook a weeklong set of activities to facilitate their understanding of the effects of X-ray exposure factor settings on image quality and patient radiation dose. A mixed methods approach using a group interview with the students in conjunction with a student evaluation form was used to assess their experiences. Analysis of both sets of data revealed a positive student learning experience, although the student perception of the purpose of RiTe needed to be more explicit. RiTe has now become integrated into the level 4 curriculum. Further work is planned to better examine the student holistic experience of RiTe.

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Integrating research-informed teaching within an undergraduate level 4 (year 1) diagnostic radiography curriculum: a pilot study

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This article discusses the piloting and evaluation of the Research-informed Teaching experience (RiTe) project. The aim of RiTe was to link teaching and learning with research within an undergraduate diagnostic radiography curriculum. A preliminary pilot study of RiTe was undertaken with a group of level 4 (year 1) volunteer BSc (Hons) diagnostic radiography students to evaluate their experiences. The students undertook a weeklong set of activities to facilitate their understanding of the effects of X-ray exposure factor settings on image quality and patient radiation dose. A mixed methods approach using a group interview with the students in conjunction with a student evaluation form was used to assess their experiences. Analysis of both sets of data revealed a positive student learning experience, although the student perception of the purpose of RiTe needed to be more explicit. RiTe has now become integrated into the level 4 curriculum. Further work is planned to better examine the student holistic experience of RiTe.

Keywords: radiography; research-informed teaching; undergraduate; pedagogy; curriculum

Introduction and background

In the UK, diagnostic radiographers play a key role in the diagnosis of disease. They take the lead responsibility for the management and care of patients undergoing a range of different imaging examinations, such as X-ray or computed tomography (CT). As a diagnostic radiographer, it is important to have the requisite knowledge and clinical decision-making skills available to be able to generate images that are fit for purpose, whilst ensuring that all patient radiation doses are kept to a minimum. Diagnostic radiographers are also required to actively engage in research and to continue to build upon the existing knowledge base to implement best clinical practice (Society of Radiographers 2011).

Increasing demands are being made on imaging services not only as result of the rise in clinical demand, but also as a consequence of the imaging requirements of on-going research studies and clinical trials. However, the number of diagnostic radiographers involved with research according to Reid and Edwards (2011) is disappointingly low and suggest that this may be due to diagnostic radiographers

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viewing research as being separate from everyday clinical practice. Although it is accepted that not all diagnostic radiographers will engage in research during their careers, a number of potential barriers have been identified that may prevent many diagnostic radiographers from participating with and undertaking research. These barriers include a lack of knowledge of research techniques and research methodology and also a fear of research itself (Challen, Kaminski, and Harris 1996).

A number of advances both professionally and educationally within the UK radiography profession have led to significant changes in teaching and learning within the diagnostic radiography curriculum and also in professional status. A key shift in UK radiography education was the move away from the traditional Diploma of the College of Radiographers (DCR) to university BSc (Hons) degree status in the early 1990s. This brought with it the concomitant requirement for graduates to demonstrate the ability to deploy accurately established techniques of analysis and enquiry within the discipline (QAA 2008). The College of Radiographers (CoR) also sought to encourage a move away from the didactic, authoritarian and inflexible 'school' model of assessment and evaluation to that of a 'university' experience with the educational focus being more evidence based practice rather than knowledge based (Malamateniou 2009; Price 2009).

Evidence-based practice (EBP) is used within the National Health Service (NHS) as a foundation for policy development and as a way to advance a culture of evaluation and learning (Reid and Edwards 2011). Systematic inquiry and thorough investigation are used to establish best practice within heath care in the NHS. This is achieved through the amalgamation of individual expertise with the best available professionally supported evidence to improve patient care and management (EBP) (Malamateniou 2009; Reid and Edwards 2011). The professional body of both therapy and diagnostic radiographers in the UK (The Society of Radiographers (SoR) has sought to encourage all radiographers to use research in their practice and to promote a cultural shift to unite research with professional standing. According to the SoRs 'Research and the Radiography Profession' strategy published in 2005, graduates of both therapy and diagnostic radiography programmes must be able to practice safely and use EBP as part of their clinical decision-making skills.

In 2009, the BSc (Hons) diagnostic radiography programme team at the University of Salford (UK) proposed changing the undergraduate diagnostic radiography curriculum in order to expose students to more hands-on research, as part of their normal teaching and learning experience. By introducing such a change in the curriculum, it was anticipated that this initiative could help create a greater understanding of research at undergraduate level, improve learning of key areas and assist in the development of vocational clinical decision-making skills. Following this proposal, the Research Informed Teaching Experience (RiTe) project was developed. The aim of the RiTe project was to combine research with inquiry-led learning and then integrate this into the undergraduate diagnostic radiography curriculum at the University of Salford.

This paper presents the evaluation of a preliminary pilot study of the RiTe project. A group of eight volunteer level 4 (year 1) undergraduate diagnostic radiography students undertook a week-long set of research and inquiry led activities to explore the effects of X-ray exposure factor settings on image quality and patient radiation dose. A mixed methods approach was used to collect and analyse student feedback with regards to their experiences and views of the RiTe project.

Literature review

There is an extensive amount of pedagogical literature that discusses the integration of research with teaching and learning in higher education (HE). However, very little disciplinary literature has been written about adopting this approach within the undergraduate diagnostic radiography curriculum.

A systematic literature search did identify work by Bungy et al. (2010) that examined the roles of personal tutors within diagnostic radiography. One of the key outcomes from this work was that students involved with research, gained a greater understanding of the research process. Nonetheless, Bungy et al. (2010), sought only to determine the role of personal tutors and ways of reducing student attrition rates, rather than the integration of research within the undergraduate diagnostic radiography teaching and learning curriculum. No other relevant disciplinary literature could be found.

Why integrate research within the diagnostic radiography curriculum?

By linking teaching and learning with research together, there are a number of advantages in which student learning is enhanced, such as the students' knowledge about a particular subject benefiting from exposure with their involvement with research (Department for Curriculum and Quality Enhancement (DCQE) 2011). However, involving students in the process of research, including the design of research strategies, collecting data and presenting research findings provide students with vital transferable skills, which according to the DCQE (2011) may be useful for subsequent career development. Baldwin (2005) also suggests like Bungy et al. (2010), that students who are actively involved in the process of research have a greater engagement with their curriculum subject matter as a result.

Challen, Kaminskit, and Harris (1996) state that in comparison with other health professional groups, diagnostic radiography is still in its infancy with regards to research as a discipline, with an over reliance on tradition and subjective experience being the accepted norms. Challen, Kaminskit, and Harris (1996) and Malamateniou (2009) suggest that a move away from accepted wisdom and practice in diagnostic radiography is needed to generate a more structured practice based upon the accumulation of empirical evidence as well as the individual's expertise to develop a more EBP approach. Both authors state that this could be achieved by introducing programmes and schemes that raise the profile of diagnostic radiography research.

Smith and Reeves (2009) elaborates upon this argument further by adding that as health professionals, radiographers need more than just clinical expertise if they are to meet the needs of a changing health system and public expectation. The ability to efficiently access and apply current best clinical practice needs to be assimilated into diagnostic radiography practice. This includes a thorough understanding of relevant literature and identifying gaps in knowledge that may exist. This newly acquired information can then be applied towards patient care and radiographic expertise as EBP (van Beek and Malone 2007).

Hafslund et al. (2008) suggest that diagnostic radiographers generate and use evidence as part of their day-to-day service delivery, but do not routinely use EBP. This is in spite of both qualified radiographers and students having requirements for being lifelong learners. Gambling, Brown, and Hogg (2003) also share the view that as clinical professionals, diagnostic radiographers should draw upon research evidence to inform their clinical practice and clinical decision-making skills. Gambling, Brown,

and Hogg (2003) state that any change in radiography practice should be evidence-based, particularly where understanding is limited and new knowledge is being created.

Integrating teaching and learning with research (the research–teaching nexus) within the undergraduate diagnostic radiography curriculum

Access to a specialised knowledge base is one of the key-defining features of developing professional practice in disciplines such as diagnostic radiography. Higher education has traditionally influenced the advancement of both the theoretical and applied knowledge of professional practice by providing a common setting for both research (knowledge advancement) and teaching (education of practitioners). Griffiths (2004), Healey (2005) and Brew (2006) suggest that rather than separating out teaching and learning and research as isolated activities, there should be a greater link between research and teaching in order to develop a *research–teaching nexus*.

The belief in a symbiotic relationship between research and teaching (or research–teaching nexus) is seen as a positive step in relation to the student university experience (McLean and Barker 2004). A number of different perspectives exist on the relationship between teaching and research and what defines the research-teaching nexus. However, it is generally accepted that the standard interpretation is based upon the degree to which students are actively engaged within the research process (The Higher Education Academy 2013).

Griffiths (2004) and Healey (2005) identified four typologies or models that describe learning activities that combine a research-based focus to constitute a research–teaching nexus. These models include (a) *research-led teaching* – students learn about research findings, (b) *research-oriented teaching* – students learn about the research process, (c) *research-based teaching* – students learn as researchers and (d) *research-tutored teaching* – student learning is focused on writing and discussing research papers. The degree of student participation with research within these models in relation to teaching and learning varies depending upon the curriculum content or the emphasis on research (see Healey 2005, 70; Malamateniou 2009; Reid and Edwards 2011).

In addition to models a-d described above, *Research-informed Teaching* (RiT) can also be included within the research-teaching nexus concept. Jenkins and Healey (2005) describe RiT as a process that deliberately uses systematic inquiry to examine the teaching and learning process itself. However, this definition is rather restrictive in its scope and fails to take into account the fact that academics draw upon a breadth of research to inform their teaching, especially in discipline-based subjects such as diagnostic radiography. It has been suggested by Haslett (2009) that a better definition of RiT might be *academic programme research*, in which the link between discipline-based research and course programme development and content is acknowledged. By using this definition, RiT can be seen as the combination of both programme research and pedagogic research. Therefore, RiT is not only concerned with exposing students to research as part of their teaching and learning curriculum, but also plays a wider role within the development of the curriculum – for example, employability, personal development planning, the learning environment and the use of technology (Jenkins and Healey 2009).

Within RiT, students learn through systematic inquiry, whilst simultaneously gaining an appreciation of research within their own discipline. RiT places the

emphasis on providing an inquiry-led approach to learning, in conjunction with the learner undertaking some form of research. The aim is to therefore to provide a synergy between these two tasks so that learners actively make sense of the new knowledge they have gained, rather than just its passive acquisition (Robertson 2006). However, RiT not only informs student learning and research development, but also integrates with the teaching process itself (Haslett 2009). This relationship can be seen in Figure 1, Haslett 2009, 3.

According to Sparkes (2007), concepts such as RiT are ripe for application and exploitation within the health care professions as they are already intrinsic to the nature of these professions, which tend to be inherently educationally vocational. This is because according to Sparkes (2007), health care practice settings are all enriching pedagogical environments, which could be explored more imaginatively within the scope of activities that utilise a RiT approach to teaching and learning.

The introduction of activities that foster RiT within the undergraduate diagnostic radiography curriculum could potentially enhance the ability and knowledge of enrolled students. In addition to this, the introduction of RiT could also help inform the development of the diagnostic radiography curriculum itself (Haslett 2009). By introducing RiT, a high-quality student learning and skills development environment may be created. This could also potentially generate diagnostic radiographers who are much more confident in undertaking research to generate EBP within their own clinical practice (Gambling, Brown, and Hogg 2003; Hafslund et al. 2008).

Developing the research-informed teaching experience (RiTe) project

Within diagnostic radiography, the ideal balance is to obtain a radiographic image, which is adequate for clinical purpose with the minimum radiation dose to the patient. It is therefore necessary to develop the necessary vocational skills for student diagnostic radiographers to be able to understand how radiographic X-ray imaging exposure factor settings influence both the image formation and radiation dose to patient (Martin, Sutton, and Sharp 1999).

In 2009, the University of Salford invested in a clinical skills facility, which included a modern imaging suite with two X-ray rooms, a CT scanner and a workstation laboratory. The clinical skills facility provides a safe environment where diagnostic radiography students can practice and develop their clinical skills using anthropomorphic (anatomically accurate) teaching/training phantoms which are used to evaluate positioning and imaging techniques under the supervision of experienced staff. These anthropomorphic teaching/training phantoms are made of materials that simulate real-life bone and tissue when X-rayed. The imaging suite is used to simulate events that resemble clinical practice (as closely as possible) in order to teach theory without causing danger to students or patients (Rush et al. 2010). The introduction of the imaging suite provided an ideal opportunity to develop an initiative whereby the students' research and vocational skills could be developed further.

It was envisaged that this initiative with suitable materials and support could lead to more formal research within the undergraduate diagnostic radiography students' normal teaching and learning experience. This could also lead to interesting and helpful research outputs from undergraduate students, including the dissemination of research findings at conferences. Following a consultative process within the BSc (Hons) diagnostic radiography programme team, the Research-informed Teaching experience (RiTe) project was developed to meet these

objectives. The RiTe project was designed to help facilitate the student's understanding of key radiographic concepts whilst undertaking an inquiry based research using a clinically based scenario.

The underlining philosophy of the RiTe project was to encourage undergraduate diagnostic radiography students to see research as something that everybody within the university had an involvement with, and provide students with the opportunity to be involved with research undertaken within the University. The RiTe project would therefore, aim to provide a true integration of teaching and research within the students' undergraduate curriculum, but would also be seen by the students to be of real value to aid their career development as diagnostic radiographers.

It was determined by the RiTe project programme team that the students would need to undertake the systematic inquiry of key areas of practice whilst following an experimental approach. A number of factors were identified that would need to be included as part of the RiTe project. These factors included only involving level 4 (year 1) students initially and therefore learning objectives suitable to level 4 academic knowledge would need to be used. This knowledge acquisition would also need to be combined with the students undertaking some form of basic research experimentation, analysis and interpretation.

Over an 18-month period, the RiTe project was refined using an iterative and incremental consultative process in order to identify clear learning and research outcomes and to define a timetable of student activities (Higgins et al. 2011). The RiTe project was designed to provide the students with a week-long set of structured events suitable to their academic level and programme of study and incorporated learning objectives that would underpin key areas of clinical practice, whilst following an experimental science approach.

Image interpretation skills are increasingly becoming a part of the newly qualified diagnostic radiographers' role. Diagnostic radiographers are required to 'justify' radiographic examinations in clinical practice – that is to decide if there is a good reason for the examination to be performed or if a repeat is required. A good knowledge of pathology, radiation protection and decision-making are all required in order to make this judgement (MacKay, Anderson, and Hogg 2006). The integration of these concepts formed an essential part of the RiTe project and a scenario was devised to drive the learning of these key skills. The scenario would require the students to investigate the relationship between radiographic X-ray exposure factor settings and their effect on both image quality and patient radiation exposure.

The RiTe project pilot

A preliminary pilot study of the RiTe project was undertaken for one week, using a group of eight volunteer level 4 undergraduate diagnostic radiography students. These eight student volunteers were then divided into two equal groups and asked to identify the following within each group:

(1) *Group Leader*. To keep the research on track, the project leader was charged with ensuring full participation of all group members and helped to moderate those who may try to dominate group discussions or work.
(2) *Recorder/Record keeper*. To keep track of unresolved issues, records the results and ensures that everyone within the group has access to this information.

(3) *Reporter*. To put together a draft of the groups', research methodology from all group members and incorporated agreed-upon-changes.
(4) *Group Member*. Actively participates in the group discussions and practical work.

The objective of the pilot was to evaluate the student experience of the RiTe project as method to combine teaching and learning with research. A timetable outlined the activities the students would undertake during the RiTe pilot week. Materials used by the students to support their learning during the RiTe pilot week included a student workbook, which introduced the students to the scenario and learning objectives and the RiTe research methodology, which provided guidance on how to minimise experimental error, control for variables and advice on conducting the research. The students used an image score-sheet devised by the RiTe programme team to record their scoring and analysis of each radiographic image acquired during the RiTe pilot (see Figure 1). However, the students were also

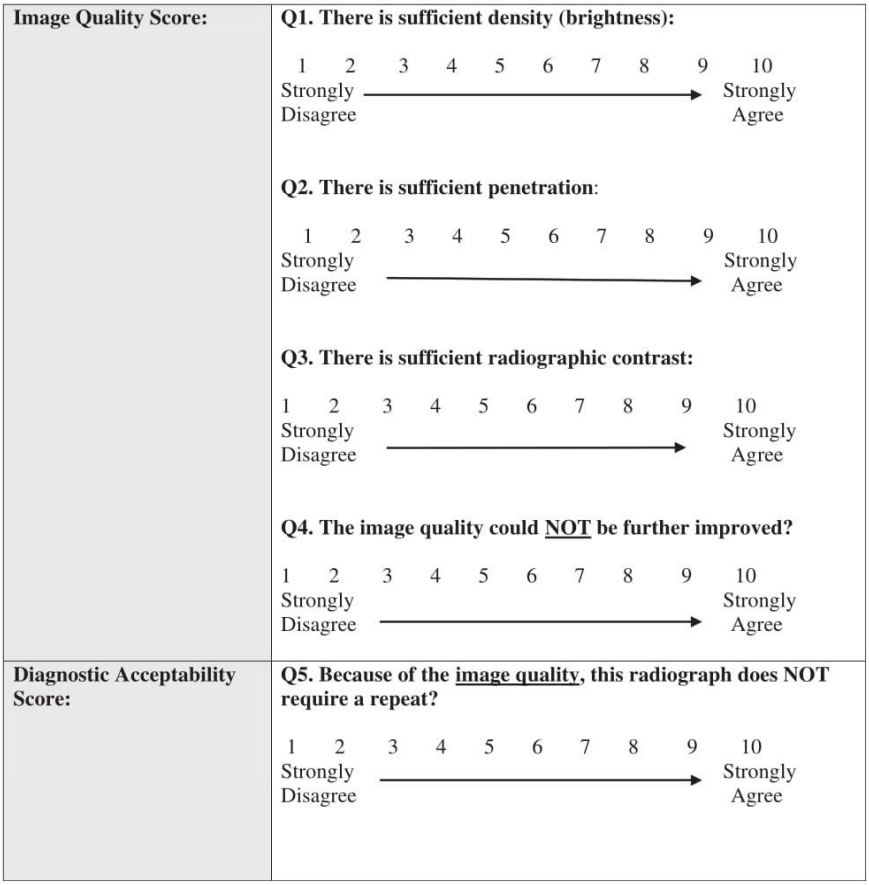

Figure 1. Image score-sheet used by the students during the RiTe pilot.

asked to design and generate their own research tool for recording the radiation dose received by the anthropomorphic phantom (which simulated a patient) for each exposure.

On day 1 of the RiTe pilot, the students undertook formal lectures that introduced the stimulus material or 'triggers' for learning and the research scenario. Triggers were used to indicate a problem or situation to prompt the students to start their research and find solutions to this problem. However, it was crucial that these triggers were appropriately focused to help lead the students to a definite set of learning outcomes related to the objectives of the RiTe project (Ma, O' Toole, and Keppell 2008). The triggers used in the RiTe pilot scenario introduced the students to the phenomenon of 'exposure creep', (a gradual increase in the amount of X-ray exposure used to generate radiographic images, which may over time result in an unnecessary increased radiation dose to patients) and the concept of radiographic image quality and how these are both affected in clinical practice by the manipulation of X-ray exposure factor settings.

The triggers used in the scenario stated that there was concern within a fictional X-ray department as there was evidence of exposure creep for a given examination (in this case the knee). The scenario instructed the students to devise a method to investigate and ascertain which X-ray exposure factor setting (or settings) for this particular examination gave the optimum radiographic image quality with lowest patient radiation dose. The scenario also asked the students how this exposure factor setting compared to the setting used in the fictional X-ray department.

In reality the exposure factor setting used in the fictional X-ray department within the scenario would have given patients a unnecessarily high radiation dose, when a lower exposure setting would have provided comparable radiographic image quality with a much lower radiation dose to the patient—it was hoped that this would give the students a greater appreciation of the importance of exposure factor selection and its implications within their own clinical environment. The concepts of experimental design and research were also discussed and time for self-directed study was provided.

The students worked in their own groups to design a methodology to investigate the scenario. Both student groups were asked to present and defend their methodologies to the RiTe facilitator. Both groups were then given the RiTe methodology designed by the RiTe programme team. The students used the RiTe methodology to guide their research objectives and outcomes during the RiTe pilot week. They were asked to compare any differences or similarities with the given RiTe methodology and their own methodology design to facilitate discussion of the research methodology design. On days 2–4 of the pilot week, both the student groups undertook their research by acquiring radiographic images using an anthropomorphic phantom under distant supervision by academic staff. The students then performed an analysis of each of these images to assess for radiographic image quality and the resultant radiation dose to the patient.

The students also reflected on the days' events in their workbooks and reported back to a RiTe project facilitator (an academic member of the RiTe programme team) on their progress at the beginning of each day. Tutor support (again by an academic member of the RiTe programme team) was provided at specific points during the week. A Ph.D. student provided the students with research skills support during the RiTe pilot week. On the final day (day 5), the students reflected on the week's events and gave a presentation of their findings and conclusions (which

exposure factor setting/s gave the optimum radiographic image quality with the lowest patient dose and how this compared to the setting used in the fictional X-ray department) to both the RiTe programme team and other student group.

Evaluation of RiTe project pilot

A small-scale evaluation of the RiTe project was undertaken following the student presentations on the final day of the pilot week (day 5). The purpose of the evaluation was to measure the extent to which the objectives of the RiTe project had been met and to identify areas of achievement or that needed improvement as part of the student experience. This was performed as part of a module evaluation, and therefore ethical approval was not required.

Data gathering

Data for the evaluation were gathered by using a RiTe project pilot student evaluation form, which was completed by all eight student participants. This was

1. What helped you to learn?

2. What hindered your learning?

3. What did you learn by undertaking this project?

4. How could this research project be improved?

5. What specific concepts are still unclear to you?

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6. Please rate the following aspects of the research project

	Very poor	Poor	Satisfactory	Good	Very good
a) Overall rating of facilities / equipment	☐	☐	☐	☐	☐
b) Overall rating of student workbook	☐	☐	☐	☐	☐
c) Overall rating of learning experience	☐	☐	☐	☐	☐
7. Overall rating of RiTe project	☐	☐	☐	☐	☐

8. Was the level of supervision	Insufficent	Just right	Too high
	☐	☐	☐

Figure 2. Student RiTe project pilot evaluation form.

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supplemented with a group interview with the students who were willing to participate with the interview.

Student RiTe pilot evaluation form

The student RiTe pilot evaluation form consisted of a mixture of open and degree of agreement and disagreement questions using a 5-point and 3-point Likert scale (see Figure 2). The degree of agreement and disagreement questions were designed to elicit quantitative data, whilst the open questions were used to collect qualitative data in terms of student views of their RiTe project pilot experience. The data were analysed using Microsoft Excel to generate descriptive statistics.

Student group interview

The final number of students who agreed to be interviewed was four. The student group interview was unstructured as to be as unobtrusive as possible and to let the students develop their own thoughts and to allow them to 'speak their minds' and explore personal accounts and feelings. Questions were asked by the RiTe programme team in order to explore the student's experiences of the RiTe pilot and how they felt about RiTe as a strategy to improve their current teaching and learning curriculum and research experience.

Three members of the RiTe project team members conducted the student group interview and included the diagnostic imaging research lead, the clinical learning manager and the Ph.D. student who provided additional support during the RiTe pilot. The interview was recorded using a video camera onto digital versatile disc (DVD). The students were assured of confidentially and anonymity during and after the RiTe pilot evaluation interview.

Student group interview data analysis

The DVD recording was transcribed verbatim by the author. Each line within the transcript was given a line unique number so that data could be located quickly and easily. Informal notes and comments were also added alongside the interviewees' comments concerning the ambience of the interview, for example gestures made by the students and observations made from the video recording. Content analysis and open coding was used to conceptualise and categorise the data. Three core categories were identified following open coding – *what helped student learning, what hindered student learning* and *the student learning experience of the RiTe pilot itself.* These core categories were used to examine and validate relationships that would assess whether the objectives of the RiTe pilot had been successfully met.

Results

Student evaluation form

Data analysis of the RiTe project pilot student evaluation form identified that there was agreement by all the students in rating the facilities/equipment, student workbook and learning experience as either being good or very good (see Table 1). The students also rated the RiTe project activity itself as being good or very good (see Table 2). All eight students agreed that the level of supervision for the RiTe pilot was just right (see Table 3).

Table 1. Question 6: Please rate the following aspects of the research project.

$n=8$	Very poor	Poor	Satisfactory	Good	Very good
Overall rating of facilities/equipment	–	–	–	4	4
Overall rating of student workbook	–	–	–	4	4
Overall rating of learning experience	–	–	–	4	4

Table 2. Question 7: Overall rating of RiTe project.

	Very poor	Poor	Satisfactory	Good	Very good
$n=8$	–	–	–	4	4

Table 3. Question 8: Was the level of supervision.

	Insufficent	Just right	Too high
$n=8$	–	8	–

The student's written feedback on the student evaluation form indicated that getting hands on experience and being allowed to experiment using the X-ray equipment helped their learning during the RiTe project pilot. One student stated that they found the Ph.D. student to be a helpful element during the RiTe pilot week:

Question 1. What helped you to learn in this activity?

- Getting hands on experience looking at exposure factors … we wouldn't normally get the chance to do this during [clinical] placement.
- To be able to use the equipment and experiment with minimal supervision
- The Ph.D. student was very good at asking questions, which provided a different way of thinking

Areas where learning was thought by the students to be hindered included a lack of motivation and or not having the knowledge to access literature relevant to the RiTe pilot prior to undertaking the research. Being taken out of clinical placement and time constraints were also identified:

Question 2. What hindered your learning?

- Lack of motivation
- Lack of knowledge about searching for literature
- Time constraints
- Being chosen during clinical placement

However, from the student evaluation form it became apparent the students did recognise the importance of exposure factor manipulation. Interestingly one student also stated the importance of being able to challenge established practices:

Question 3. What did you learn during by undertaking this work?

- How exposure factors, radiation dose and image quality are interlinked

- Increasing the exposure factors unnecessarily increases patient dose
- Always question everything!

Areas suggested by the students that needed improvement included issues with the image score-sheet used during the pilot. Making more time available in order to undertake the work required during RiTe was also identified:

Question 4. How could this activity be improved?

- The image score-sheet scale could definitely be improved
- More time!

Finally, for Question 5 (What specific concepts are still unclear to you?), a number of technical related concepts were raised related to diagnostic radiography X-ray exposure factor manipulation. These comments are not discussed here as they lie outside the knowledge and interest of the readership.

Student group interview

The open coded group student interview data were triangulated with the written feedback gathered from the student evaluation form. This confirmed there was a consensus of agreement by all the students who participated with the group interview and completed the student evaluation form that they saw the RiTe project pilot as a beneficial learning experience. The data below indicates that the students found the RiTe pilot week to be a positive or enjoyable experience:

RiTe programme team: Did you like the RiTe week?

- Not at first, but as the week went on, yes
- Yes, it was difficult at first as we tried to understand what was going on, but we enjoyed being able to question things

One of the main areas of positive student feedback from the data included the interaction with the Ph.D. student. The Ph.D. student did not have a professional diagnostic radiographic background, but was researching radiographic image quality, patient radiation dose and the use of spinal support aids within their sphere of practice, orthotics (the medical design and application of medical devices to correct or immobilise the shape or function of the body). The students appreciated the help given by the Ph.D. student in facilitating the research and data analysis, but also in challenging their understanding of the key fundamental radiographic concepts they were researching:

- The Ph.D. student questioning us helped us to think about the effect about exposure factors and image quality, but not just as a radiographer

Other areas of positive student feedback identified within the data, which facilitated student learning included being able to use the X-ray equipment to undertake experimental work. Again within the group interview, the notion of being able to question their own knowledge was raised:

RiTe programme team: What helped you to learn during RiTe?

- Using the equipment and being able to experiment with minimal supervision
- Questioning everything I do, thinking about and creating own [research] methods
- Getting hands on experience looking at exposure factors … we wouldn't normally get the chance to do this during [clinical] placement

Hindrances to student learning or areas for improvement identified from the data analysis included the design of the image quality X-ray score-sheet used during the pilot by the students to assess and score their acquired radiographic images. One of the students from the interview group felt that the scale used in the score-sheet needed to be made easier as they felt they lacked the experience and confidence to accurately judge radiographic image quality, especially when comparing results with their peers. This facilitated discussions between the RiTe programme team and the students during the interview regarding image analysis and how this can be a subjective process and may change with experience.

However, the X-ray score-sheet did help the students to analyse a large number of images easily and quickly during the pilot week. Other areas of hindrance to student learning identified from the data analysis included a lack of knowledge of how to search for relevant literature and difficulties with meeting deadlines:

RiTe programme team: What hindered your learning during RiTe?

- I lacked knowledge about how to use the computers to search for literature related to the RiTe work
- I definitely feel that the scale on the score-sheet could be improved
- We had a number of time constraints as a result of going off on tangents at times

Some of the students also raised issues with a lack of motivation. This was due in part at being taken out of their clinical placements and undertaking what they perceived to be academic work within the RiTe pilot:

- I did not fully understand the purpose of the RiTe pilot
- I didn't realise that I was going to be chosen to do it during clinical placement and not free time

There was, however, overall agreement by the students in both the group interview and student evaluation forms that they found the RiTe pilot to be helpful in terms of learning and research. This was mainly because the students were able to undertake learning within an environment that allowed them to explore and challenge established radiographic concepts:

- It helped us to understand a bit better what affects X-ray images

It was also identified from the data analysis that the students felt that the RiTe pilot had in fact changed their perspective about clinical practice. However, one student did made a comment during the group interview about not being able to share this newly acquired knowledge with qualified radiographers:

RiTe programme team: Will this experience change your perspective on the way things are done?

- Yes. Although change is not something really we can do. Radiography is new science, a growing science but as newly qualified radiographers, senior radiographers may ask who are we to question the protocols used? Change is not something we can do

RiTe programme team: We need a new generation [*of diagnostic radiographers*] to challenge these established protocols with evidence based practice, especially now with the development of new techniques and technologies.

Discussion

Malamateniou (2009) states that the development of radiography research and EBP within the UK needs be highlighted as a priority in order to further the discipline. The communication of research and EBP should also be viewed as being just as important as the undertaking of research itself. However, in order to achieve this aim there is a need to encourage the provision and full integration of a research culture within diagnostic radiography.

King and Peterson (2002) state that increasing demands are being placed on HE to generate learners that are high knowledge-skilled graduates. The concept of a *knowledge economy* whereby knowledge is seen as a key economic commodity is thought to make students more attractive to potential employers. Graduates are therefore distinguished from each other by their level of knowledge-skill (Scott 2005; Brine 2006).

In order to meet the demands of the knowledge economy, activities that raise the profile of research and adopt learning strategies that both support and operate alongside current expository approaches to teaching and learning within HE have been introduced. One such approach is the integration of research with teaching within the undergraduate curriculum to generate a research–teaching nexus (Griffiths 2004; Healey 2005).

The introduction of activities such as RiT is one strategy whereby students are actively engaged with the information they are required to learn (Griffiths 2004; Haslett 2009). Such an approach may provide educated practitioners who have the desire to further the existing knowledge base as a consequence of undertaking a curriculum which has teaching and learning integrated with research experience. By using RiT within the undergraduate teaching and learning curriculum, not only are students exposed to more research as part of their teaching and learning curriculum to improve their learning experience, but potentially curriculum development and course programme development planning could be further developed as a consequence of pedagogical research into the process itself (Haslett 2009).

The introduction of initiatives such as the RiTe project within undergraduate diagnostic radiography curriculum may go some way in generating newly qualified radiographers who are not only highly skilled, but also much more confident in participating with and undertaking research. This may also help to facilitate the provision of EBP within diagnostic radiography. During the RiTe project pilot, a group of eight volunteer level 4 undergraduate students undertook inquiry led research (albeit within parameters) to explore the effect of changing X-ray exposure factor settings on radiographic image quality and patient radiation dose, which forms a key part of their vocational education and clinical skill development as diagnostic radiographers.

Following evaluation of the RiTe pilot, the results would seem to support the fact that students viewed such an approach to be a beneficial learning experience. This was in part due to the students being able to use X-ray equipment to explore the effects of altering exposure factor settings on radiographic image quality and patient radiation dose (using an anthropomorphic phantom) – this is something they would not have the opportunity to do within their clinical placements. The students also valued the input of the Ph.D. student who challenged their preconceptions of what they were researching and how this would apply to their roles as diagnostic radiographers.

The Ph.D. student became involved with RiTe in order to help develop their teaching and supervision skills. This was consistent with their Ph.D. candidature and in addition provided support to the university teaching diagnostic radiography team during the RiTe pilot as teaching resources were limited at that time (three vacant teaching posts had not been filled within the department following the departure of these members of staff).

This situation has now changed due to a full staff compliment within the teaching team and this will help to ensure the future sustainability of RiTe within the normal resources allocated for the undergraduate diagnostic radiography curriculum. However, the introduction of Ph.D. students to supervise students within activities such as RiTe could potentially provide additional benefits in exposing undergraduate students to the idea that undertaking research is an attractive and possible career pathway following graduation.

The students also gained an appreciation of the effects of exposure creep and the consequences of this on radiographic image quality and patient radiation dose whilst undertaking research within the RiTe pilot. This was mainly because the subject matter selected within the RiTe pilot was relevant to their learning and career development as diagnostic radiographers. However, because the RiTe project was something the students had not previously experienced before, they were not completely certain of what was expected of them during the pilot. Some students also saw RiTe as academic work or research rather than as a teaching and learning experience combined with research.

However, the students involved with the RiTe project pilot did respond positively with the objectives of RiTe. It was also identified that more work was required in order to help students identify RiTe as a potential method to bridge the gap between what they are taught in the classroom and what they experience when on clinical placement. The dichotomy between the theoretical input taught and what is actually practised/experienced by the students on placement or theory–practice gap, is well documented within the nursing literature (Landers 2008). However, this may also apply to other health professions such as diagnostic radiography, but may not be as well documented or researched. RiTe may help to provide closer sequencing between what the students learn whilst on clinical placement and the theory taught in the classroom.

Despite the initial success of the RiTe project pilot, further work is still needed to examine the relationship of linking research and teaching and the impact this has on undergraduate knowledge of the discipline of diagnostic radiography. It must be acknowledged that the introduction of group work and the assigning of student roles within these groups during the RiTe pilot are pedagogical interventions and along with tutorial support and the input from Ph.D. student, may have unintentionally influenced the outcomes of the pilot. However, the role of student group work

and the assignment of roles within these groups during RiTe could be a potential area for future study to explore how such interventions are viewed by the students.

Another potential source of error within the RiTe pilot is the introduction of interviewer bias. The power relationship of the RiTe programme team with the students may have potentially influenced the outcome of the group student interview responses being more favourable had the interviewers not been members of the undergraduate diagnostic radiography teaching team.

Conclusion and summary

The objective of the RiTe project was to encourage students to undertake a systematic inquiry led approach to learning by exploring key areas of practice suitable to level 4 undergraduate student teaching and learning outcomes. Early evidence from the RiTe project pilot would seem to suggest that these objectives were met.

The volunteer group of level 4 students who participated within the pilot evaluated it as a positive teaching and learning student experience by a small group of undergraduate diagnostic radiography student volunteers. The students also felt that RiTe had would help to facilitate their learning and translation of taught theory into clinical practice as the RiTe pilot used an approach that simulated a research process to explore concepts relevant to their career discipline – exposure creep and the consequences of this on diagnostic image quality and patient radiation dose.

However, the introduction of group work and the assigning of student roles during the pilot alongside tutorial and Ph.D. student support may have influenced the attainment of these outcomes. Bias of the results may have also been introduced as a result of the power relationship of the interviewers who were university diagnostic radiography teaching staff resulting favourable feedback from the students to questions posed about the pilot.

Nonetheless, following positive student feedback from the pilot, RiTe now forms part of the students' level 4 summative assessment within the diagnostic radiography curriculum. This is sustained as part of the normal resourcing for the undergraduate diagnostic radiography curriculum. Both the process of RiTe (student presentations) and content (written reports by the students) are assessed to identify student learning and to highlight areas that may require further study. More information is now given to the students prior to their participation within RiTe, alongside better promotion of the benefits and objectives of RiTe to address the issue raised during the pilot of students not fully understanding the purpose of RiTe.

Yorke (2006) states that undergraduate research should be linked to student employability by making it relevant to the students to help improve their appreciation of the role of research within their future careers. Jenkins and Healey (2005) also suggest that it is important to ensure that curriculum assessment practices and policies therefore support students as researchers. Within the RiTe project, the aim is to achieve both of these goals by providing teaching and learning using research that is relevant to the student's clinical experiences and knowledge for their careers as diagnostic radiographers and to have the confidence and skills to undertake EBP. The students who participated with the RiTe project pilot were encouraged to disseminate their research findings during the RiTe pilot and presented a poster at one of main UK radiological conferences – the UK Radiological Congress (UKRC). It is hoped that in the future undergraduate diagnostic radiography student conferences and exhibitions could be held within the University of Salford itself.

The College of Radiographers/Nuffield Foundation radiography undergraduate research bursary awarded funding to an undergraduate diagnostic radiography student at the University of Salford, who had previously undertaken RiTe. The student applied for a bursary to gain further research experience and extend their knowledge gained following their positive experience of RiTe. This funding will be used by the student to undertake research as part of a university team examining a wide range of imaging conditions and their effect on image quality using a chest phantom (Society of Radiographers 2012).

Further work

Further work is currently being undertaken to build upon RiTe and develop this further to generate learning outcomes suitable to level 5 (year 2) students (RiTe II). RiTe II will logically follow from RiTe, but the rigour of the expected academic progression and attainment will be taken to greater depth than with RiTe (Norton et al. 2012). This will also encompass some of the areas identified from the RiTe pilot student evaluation mentioned earlier in Question 5 of the RiTe pilot student evaluation form that the students felt were still unclear to them.

A detailed evaluation of RiTe is planned and ethical approval has been granted to conduct a formal qualitative study. This study will investigate the students' holistic experience of RiTe and explore further the concept of combining research with teaching and learning within the radiography curriculum at the University of Salford. It is also envisaged that the university staff and clinical tutors' views and experiences of RiTe and potential impact of RiTe on the development of the undergraduate diagnostic radiography curriculum will also be investigated.

References

Baldwin, G. 2005. *The Teaching Research Nexus: How Research Informs and Enhances Learning and Teaching in the University of Melbourne*. Melbourne: Melbourne Centre for the Study of Higher Education, University of Melbourne. www.cshe.unimeb.edu.au/downloads/TR_Nexus.pdf.

Brew, A. 2006. *Research and Teaching: Beyond the Divide*. London: PalgraveMacmillian.

Brine, J. 2006. "Lifelong Learning and the Knowledge Economy: Those that Know and Those That Do Not – The Discourse of the European Union." *British Educational Research Journal* 32 (5): 649–665.

Bungy, H., S. Gibson, J. Gibbs, R. Denton, and K. Springett. 2010. "The Influence of the Personal Tutor in Supporting Students with Specific Reference to Attrition." In *Research Informed Teaching: Exploring the Concept*, edited by L. Graham-Matheson, 42–43. Canterbury: Canterbury Christ Church University.

Challen, V., S. Kaminskit, and P. Harris. 1996. "Research-mindedness in the Radiography Profession." *Radiography* 2: 139–151.

Department for Curriculum and Quality Enhancement (DCQE), University of Plymouth. 2011. "Curriculum 2012 – Briefing Note 5: Research Informed Teaching." www.port.ac.uk/.../services/dcqe/developingyouracademicpractice/downloads/filetodownload,114564, en.pdf – 2011-08-12.

Gambling, T., P. Brown, and P. Hogg. 2003. "Research in our Practice – A Requirement not an Option: Discussion Paper." *Radiography* 9: 71–76.

Griffiths, R. 2004. "Knowledge Production and the Research-teaching Nexus: The Case of the Built Environment Disciplines." *Studies in Higher Education* 29 (6): 709–726.

Hafslund, B., J. Clare, J. Graverholt, and M. W. Nortvedt. 2008. "Evidence-based Radiography." *Radiography* 14: 343–348.

Haslett, S. K. 2009. "Unpicking the Links Between Research and Teaching in Higher Education." *Newport CELT Journal.* 2: 1–4.

Healey, M. 2005. "Linking Research And Teaching: Disciplinary Spaces." In *Reshaping the University: New Relationships Between Research, Scholarship and Teaching*, edited by R. Barnett, 30–42. Maidenhead: McGraw-Hill/Open University Press.
Higgins, R., P. Hogg, L. Robinson, A. Newton-Hughes, K. Szczepura, and A. Tootell. 2011. "The RITE Project: Towards a Research-Led Curriculum in a Diagnostic Radiography Degree." *Synergy* 6: 26–28.
Jenkins, A., and M. Healey. 2005. *Institutional Strategies to Link Teaching and Research*. York: The Higher Education Academy.
Jenkins, A., and M. Healy. 2009. "Developing the Student as Researcher Through the Curriculum." *CETL Journal: Innovation in Practice* 2 (1): 1–15.
King, T., and P. Paterson. 2002. "Problem-based Learning in Higher Education: Theory Into Practice." Draft paper presented at the Higher Education Research and Development Society of Australasia (HERDSA) Conference: Quality Conversations, Perth W. Australia, July 7–10 2002.
Landers, M. G. 2008. "The Theory–Practice Gap in Nursing: The Role of The Nurse Teacher." *Journal of Advanced Nursing* 32 (6): 1550–1556.
Ma, A. K. F., J. O'Toole, and M. Keppell. 2008. "An Investigation of Student Teachers' Attitudes to the Use of Media Triggered Problem Based Learning." *Australasian Journal of Educational Technology* 24 (3): 311–325.
MacKay, S. J., A. C. Anderson, and P. Hogg. 2006. "Preparedness for Clinical Practice – Perceptions of Graduates and Their Work Supervisors." *Radiography* 14: 226–232.
Malamateniou, C. 2009. "Radiography and Research: A United Kingdom Perspective." *Radiography* 1: 2–6.
Martin, C. J., D. G. Sutton, and P. F. Sharp. 1999. "Balancing Patient Dose and Image Quality." *Applied Radiation and Isotopes* 50 (1): 1–19.
McLean, M., and H. Barker. 2004. "Students Making Progress and the 'Research-Teaching Nexus' Debate." *Teaching in Higher Education* 1 (4): 407–419.
Norton, S., P. Hogg, R. Higgins, L. Robinson, S. Mackay, E. Norton, K. Szczepura, et al. 2012. "Further Developments in a Research-led Diagnostic Radiography Curriculum." *Synergy* 9: 20–23.
Price, R. 2009. "Diploma to Degree 1976 to 1993." *Radiography* 15: 67–71.
QAA. 2008. *The Framework for Higher Education Qualifications in England, Wales and Northern Ireland*. Mansfield: The Quality Assurance Agency for Higher Education.
Reid, K., and H. Edwards. 2011. "Evaluating the Role of the Diagnostic Research Radiographer." *Radiography* 17: 207–211.
Robertson, A. 2006. *Research-Informed Teaching*. Edinburgh: The Higher Education Academy. www.hw.ac.uk/edu/LTD_march_06_files/AlastairRobertson.pdf.
Rush, S., L. Acton, K. Tolley, D. Marks-Maran, and L. Burke. 2010. "Using Simulation in a Vocational Programme: Does the Method Support the Theory?" *Journal of Vocational Education and Training* 62 (4): 467–479.
Scott, P. 2005. "Universities and the Knowledge Economy." *Minerva* 43: 297–309.
Smith, S., and P. Reeves. 2009. "The Extension of the Role of the Diagnostic Radiographer in The UK National Health Service Over the Period 1995–1999." *European Journal of Radiography* 1 (4): 108–114.
Society of Radiographers. 2005. *Research and the Radiography Profession: A Strategy and Five Year Plan*. 5th ed. London: The Society and College of Radiographers.
Society of Radiographers. 2011. "About Radiography." http://www.sor.org/about-radiography.
Society of Radiographers. 2012. "Budding-researchers-celebrate-funding-awards." http://www.sor.org/news/budding-researchers-celebrate-funding-awards.
Sparkes, V. 2007. "Research-informed Teaching in Health Professional Education." *International Journal of Therapy and Rehabilitation* 14: 7.
The Higher Education Academy. 2013. "Research/Teaching Nexus." http://www.heacademy.ac.uk/hca/themes/practice/rtnexus.
van Beek, E. J. R., and D. E. Malone. 2007. "Evidence-based Practice in Radiology Education: Why and How Should we Teach It?" *Radiology* 243: 633–640.
Yorke, M. 2006. *Employability in Higher Education: What It is – What It is Not*. York: The Higher Education Academy.

PAPER 2:

TOWARDS A RESEARCH INFORMED TEACHING EXPERIENCE WITHIN A DIAGNOSTIC RADIOGRAPHY CURRCIULUM: THE LEVEL 4 (YEAR 1) STUDENT HOLISTIC EXPEREINCE

University of Salford MANCHESTER

Towards a research informed teaching experience within a diagnostic radiography curriculum: The level 4 (year 1) student holistic experience

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Towards a research informed teaching experience within a diagnostic radiography curriculum: The level 4 (year 1) student holistic experience

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ABSTRACT

Aim: This article discusses the level 4 (year 1) diagnostic radiography student holistic experience of the Research-informed Teaching experience (RiTe) at the University of Salford, UK. The purpose of RiTe is to expose undergraduate radiography students to more formal research, as part of their normal teaching and learning experience.
Method: A grounded theory approach was adopted and a focus group with eight level 4 students was used to explore and evaluate the student experience and perception of RiTe.
Results: Open coding defined categories and sub-categories, with axial and selective coding used to interrogate and explore the relationships between the focus group data. A number of insights were gained into the student holistic experience of RiTe. The issue of leadership for level 4 students was also identified.
Discussion: The focus group participants found RiTe to be an extremely positive learning experience. RiTe also facilitated their translation of learnt theory into clinical skills knowledge alongside their understanding of and desire to participate in more research as undergraduates. The article also highlights areas for future research.

Introduction and background

Access to a specialised knowledge base is one of the key-defining features of developing professional practice. Higher education has traditionally influenced the advancement of both theoretical and applied knowledge of professional practice by providing a common setting for both research or *knowledge advancement* and teaching or *education of practitioners*.[1] However, there is a growing demand to combine these traditionally separate activities together to develop a 'research- teaching nexus'; the aim being the improved development of undergraduate professional practice and life-long learning. Research-informed Teaching (RiT) is one such approach whereby students learn via systematic inquiry and develop an appreciation of research within their own discipline.[2,3]

In 2009, the BSc (Hons) diagnostic radiography programme team at the University of Salford, United Kingdom (UK) proposed changing the curriculum for the undergraduate diagnostic radiography students in order to expose them to more formal research, as part of their normal teaching and learning experience. It was envisaged that such an initiative with suitable materials and support could lead to valuable research outputs from their contributions, but also facilitate the students practice based learning and understanding of key radiographic concepts.

The Research-informed Teaching experience (RiTe) was developed to combine elements of inquiry led learning and research, with level 4 (year 1) undergraduate radiography students exploring the relationship between kVp with a fixed mAs on both the image quality and dose area product (DAP). RiTe was piloted for one week on two separate occasions, using two groups of volunteer level 4 radiography students. Each week consisted of two groups of four level 4 students following an inquiry based scenario using the phenomenon of exposure creep as a trigger.[4] This trigger was used by the students to investigate the relationship between increasing kVp with a fixed mAs on both image quality and DAP using an anthromorphic phantom knee. The students then analysed the data collected and presented their findings at the end of each pilot week. Student and staff feedback from both pilots was extremely positive and RiTe was fully integrated into the level 4 diagnostic radiography teaching and learning curriculum as part of their assessment in January 2011.[5]

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Aim

The undergraduate student experience is crucial to many research educators in better understanding the phenomena of student learning and development.[5] However, despite RiTe being integrated within the level 4 diagnostic radiography learning curriculum, there had been no formal evaluation or research undertaken to examine the students' holistic learning experience of RiTe.

Three core objectives were identified for research. These core objectives would explore the level 4 students' holistic experiences of RiTe and determine whether RiTe helped in the transition of learnt theory into applied knowledge. The final core objective would examine from the students' perspective whether RiTe had the potential to influence their approach to both clinical practice and research.

The research outcomes would also help to inform the development of a questionnaire for subsequent research. This questionnaire would be used to further explore the level 4 student experience of RiTe with a greater population size.

Method

Grounded theory was used explore the students' holistic experience of RiTe as it is a constant comparative methodology that seeks to identify the 'story' of the data being analysed. It also permitted the researcher to choose techniques in their reconstruction of the participants' data to better explore the research outcomes.[6–9]

A focus group was used to explore the students' attitudes, perceptions and feelings about their RiTe experience. A focus group was chosen as the preferred method as it would inform the content of the questionnaire, obtain general background information about the student holistic experience of RiTe and stimulate new ideas.[10,11]

The researcher acted as 'moderator' and a topic plan with a number of 'triggers' was used to guide the discussion (see Table 1). These triggers would enable the participants to share their experiences with each other and help identify any degree of consensus or difference of opinion.[12]

Ethical approval

Ethical approval (HSCR12/12) was granted prior to recruiting students to participate in the focus group and good ethical practice for conducting focus groups was followed. This included the use of informed consent via an information sheet for all participants, and set of focus group guiding principles (See Table 2). All participants were assured of confidentially and anonymity during and after the focus group.[11,12]

Sampling and recruitment

A stratified and purposive sampling approach was used in recruiting students to participate in the focus group. The participants would all share a common characteristic, in that they all had experienced RiTe as level 4 students. The programme leader approached the five RiTe level 4 student groups. There were eleven students within each of these five RiTe groups, and from each group the programme leader sought to identify those students who would be willing to participate in the focus group and share their experiences of RiTe as part of a research project.

From those students willing to participate, the programme leader identified eight participants from across the five RiTe groups. Selection was based on their suitability in offering their feedback and experience and also their availability to participate as part of a homogenous focus group. The literature varies on the optimal size of a focus group, but typically it will consist of between four-twelve participants, with the minimum recommended number of focus groups being two (depending on the issue being investigated and the amount of diversity required).[10,11,13] However, due to the limited number of suitable participants selected, which was due in part to student timetable issues coinciding with the focus group, only one focus group was used in the research. As a consequence selection bias has to be acknowledged as a possible source of systematic error, limiting the generalisabilty of the research, but not its internal validity.[14] It was envisaged that the focus group would last between 60 and 90 min. All eight participants invited to the focus group attended.

The programme leader played an important role with the research design development. Having insider knowledge, they were able to contribute to the management and logistics of the research. However, they were not involved with the design of the research data collection tool, the focus group itself or the data analysis.

Table 1
Topic plan with focus group triggers.

1. Tell me about your experience of RiTE, please think broadly (holistically) when responding to this question
2. What helped you to learn during RiTE?
3. What (if anything) hindered your learning with RiTE?
4. What did you learn during RiTE?
5. Do you think your experience within RiTE will influence your approach to clinical practice?
6. What about student involvement with research?

Table 2
Focus group guiding principles.

1) Only one person talks at a time.
2) Confidentiality is assured – "What is shared in the room stays in the room".
3) It is important for us to hear everyone's ideas and opinions. There are no right or wrong answers to questions – just ideas, experiences and opinions, which are all valuable.
4)It is important for us to hear all sides of an issue – both the positive and the negative.
5) Invite participants to establish their own ground rules or guiding principles for the discussion.

Data collection

Data was collected using a digital audiotape to record the focus group participants' views and field notes were also taken to provide a permanent record of the researcher's interpretation of what was said and to act as point of reference during the data analysis.[15] The focus group explored the student experiences, attitudes and perceptions about RiTe and lasted for 60 min. All responses were recorded in an anonymous basis and each participant was given time to make a comment without interruption of other focus group members.

Data analysis

The focus group recording was transcribed verbatim. Each line within the transcript was given a line unique number so that data could be located quickly and easily. Informal notes and comments from the field notes were also included as part of the analysis following transcription.

Open coding was used to conceptualise and categorise the data. Four core categories were identified following open coding – *the student holistic experience of RiTe*, *student learning and acquired knowledge following RiTe*, *changes in student clinical practice following RiTe* and *changes of student perception of research following*

RiTe. Three sub-categories within these core categories were also identified – *positive student learning experiences*, *negative student learning experiences* and *further student involvement within research*.

Axial coding related these sub-categories to a category, compared the categories with the collected data, expanded the density of the sub-categories by detailing their properties and dimensions, and finally explored any variations in the phenomena of the student experience of RiTe.[6]

Finally, selective coding built upon the foundations of axial coding to systematically identify relationships between each category and sub category, refine and validate these relationships and pull these together to form an 'explanatory whole' and identify the consequences that resulted from these to identify the 'story' of the transcribed data.[6,8,9]

Results

The majority of the focus group participants stated that they felt RiTe was a positive or good experience, although the students prioritised group and team working as their main holistic experience of RiTe, this has also been identified as a key role of the diagnostic radiographer – that of being able to work in teams[16]:

> *I thought it was quite good… it was good to get experience of interacting with other people …* (R2 line 12–16)

> *I liked the team working and getting to know other people. I don't usually like to speak when I first meet people, but at the end I was the only one who was talking* (R6 line 62–66)

> *Yeah, what I really liked about it maybe is just working in my group. Some people have their own friends… You did not have a choice which group you belonged to… so at the end we made new friends* (R7 line 67–72)

Only one participant (R4) from the focus group stated that they found RiTe not to be an enjoyable experience:

> *Despite everything, I hated it!* (R4 line 30)

When asked why this was, the participant stated that they found the group work difficult. This was as a result of personality issues with some of the other group members.

However, this participant did go on to say that:

> *I have to confess that actually I did come out of it really feeling a load more confident…* (R4 line 34–36)

The undertaking of experiments and research as part of RiTe was seen by the focus group as being very helpful with their learning. A better understanding of image quality and the effects of kVp were prioritised as key learning experiences:

> *It helped us to understand it a bit better and how it [kVp] affects images and dose [DAP]* (R1 line 100–102)

> *I think that it was good educationally. All of the things we get told about in lectures… We don't actually get to spend time looking at images and trying to see what that is in practical terms* (R4 line 158–163)

One participant stated that they did not have any experimental background, but now felt more confident about undertaking research:

> *Unlike some of the other group members, I don't have a science background… I have learnt at lot from it [RiTe]* (R6 line 206–207)

> *Some members of the group didn't come from a very academic background and hadn't done anything like it [RiTe] before* (R2 line 128–132)

The main negative experience reported by the focus group during RiTe included a perceived lack of knowledge or skills in using Microsoft (MS) Excel to generate graphs or MS PowerPoint to generate presentation slides:

> *We could have done with that knowledge [Excel]…, because our side spent a lot time going this is how you use it… but we were also trying to do other things as well and it was quite difficult* (R1 line 384–387)

> *None of us could remember how to put standard deviation bars on [Excel], we all knew what they were, but we couldn't remember how to do it…* (R4 line 357–359)

Although seen as negative experience initially, the participants had in fact identified a learning deficiency within RiTe. The programme team are now looking as ways to address this as a student learning issue.

Another source of negative feedback was the lack of an explanation of why 4 mAs had been selected as the constant for the research in RiTe. This was felt by the focus group to be a slightly higher setting than perhaps than that used within clinical placements. This had in fact been chosen deliberately by the programme team to generate discussion and debate by the students as part of their analysis of the results. Some of the focus group participants also found their RiTe experience difficult at first as they had expected to be instructed on how to approach their work:

> *I thought that the first day with the piloting was a complete waste… not a complete waste of a day, but mostly a waste of a day. We didn't quite know what we were looking at, so we were looking at SID, looking this up and the other and there was no set form to it…* (R4 line 300–309)

However, some participants found this approach to be a very enjoyable element of RiTe:

> *Completely disagree with you! I thought the first day was great, that the pilot study was really helpful and informative and what we discovered from our pilot studies, we then used for the experiment* (R5 line 324–327)

Interestingly, group and team working was again identified as key experience of RiTe, but this time it was viewed as a negative experience by some of the participants:

> *Part of our groups biggest hindrance was just really ourselves, because you stayed within a room and then go and do it and we were like three o'clock and go home I think we're done!* (R2 line 268–271)

The focus group also felt that the research undertaken during RiTe would influence their clinical practice. This included an increased knowledge of manipulating the kVp and its effect on the image quality and DAP:

> *Although we are taught about it [kVp], we never really knew what difference an additional 5 [kVp] would make. Up until RiTe week, I really didn't understand it* (R1 line 606–610)

However, the majority of participants felt unable to share this knowledge with qualified radiographers:

> *I just agree with what R1 has said. It made me think before you just kind of get a twitch and not knock it up [kVp], but the way it was presented during the week, stood out for me. No way you would say to a qualified radiographer 'Well in our RiTe week …', but it did have application, maybe it would make you think before you did it* (R2 line 619–623)

> *R2 has already said, you wouldn't sort of go 'You shouldn't being doing that'. So, I think from my point of view it would*

change my practice but I don't think I'd tell anybody else (R3 line 636–639)

I have learned that I'm not going to bring the kVp up by 5 or whatever unless it is justified for a good reason. I never dare tell the radiographer to…(R6 line 667–669)

This was something that the focus group felt very strongly about, and this was documented in the researchers' field notes as an area to explore further. The majority of participants stated that they would be unable to approach or challenge qualified staff with the knowledge gained from RiTe, though the reason for this was unclear. This was an unexpected finding and identified that changing practice is not just necessarily about translating knowledge into practice, but is also about people, personalities and *leadership*. This raised the question to the programme team – *should the undergraduate curriculum have these skills built into it prior to level 4 student clinical placement to prepare students or was it simply because these students have limited clinical placement experience and confidence, unlike their level 5 (year 2) or 6 (year 3) compatriots?*

Some of the participants did go further to suggest that this was less of an issue following qualification and again may support the notion of introducing leadership skills at an early stage within the undergraduate curriculum:

It's more of having self confidence really, once your qualified you know that you have the authority to be able to help people and pass on the information that you have (R4 line 730–735)

However, the some of the focus group participants did feel comfortable in sharing their current RiTe experience with their peers:

I would definitely share that information with other first year [level 4] students (R1 line 698–699)

The focus groups' perception of RiTe and its application to radiography was that of an increased awareness of the role of research and experimental work within radiography:

One thing that I did learn from the RiTe was that there is no research in radiography. It's going to help in the long run and make things better for the patients and make our jobs a bit easier. So I thought it was a good idea and I enjoyed it (R3 line 721–728)

Finally, there was great interest by the focus group participants to have more student involvement within research and participate with experimental work undertaken within the University:

When we were in, they were doing the breast tissue experiment that's [been] written up and we got to see a bit of that…It was good to see actual research being carried out as we were doing ours … (R3 line 1126–1131)

I think it… it pushes you ahead of the crowd and you can say 'Well I've actually been picked to take part in this research and helped with this' from a sort of selfish point of view it looks good on your C.V. (R3 line 1061–1066)

It would be good to work alongside someone [doing research]…(R8 line 1138)

Discussion

RiTe was seen by the focus group to be a beneficial holistic learning experience. RiTe also helped to increase the focus groups' knowledge of the effects of manipulating kVp on image quality and DAP and the application of these within the clinical environment. The focus group also stated that they had gained a greater appreciation of the role of research within radiography and some members were very keen to have more involvement with research undertaken at the University.

One of the main priorities identified by the focus group as a key learning experience of RiTe was that of group and team working. This tallies with the social constructivist theory of learning, whereby learning is largely a social process and not a matter of educators telling learners what they need to know.[2,3] The focus group was positively in favour of having more involvement with research as part of their teaching and learning experience. This is of one of the tenets of RiT, where students are actively encouraged to have a greater involvement with staff and researchers and contribute to the development of their own discipline.[3]

A point of interest was the feeling by the focus group that they felt unable to share or challenge qualified radiographers with the knowledge they had gained following RiTe. This was something not previously considered by the researcher and raised the issue of leadership. However, some of the focus group participants did feel more confident in sharing this knowledge with other students. Only following qualification, did the majority of the focus group participants feel confident enough to share their acquired RiTe knowledge with other radiographers.

Conclusion and summary

The objective of RiTe was to encourage students to undertake a systematic inquiry led approach to learning by exploring key areas of practice suitable to level 4 undergraduate student teaching and learning outcomes. Evidence from the focus group demonstrated that the student holistic experience of RiTe was that of a valuable and extremely positive learning experience. The majority of the focus group also felt that RiTe had helped to facilitate their learning and translation of taught theory into clinical practice. By using an approach that simulated a research process to explore these concepts, a desire to undertake further research by the focus group was also fostered.

The information gained from the focus group analysis will be used to inform the content of an on-line questionnaire. This questionnaire will investigate the level 4 student holistic experience of RiTe with a larger number of respondents, as the focus group limits the generalisation of results to the wider population. This will be used to explore further the concept of combining teaching and learning with research as originally proposed, but also the issue of undergraduate student leadership.

The programme team encouraged some of the students who participated within the original RiTe pilot work to submit a poster of the work they had undertaken and what they learnt. This was accepted and presented at the United Kingdom Radiology Conference (UKRC) in June 2011.[17] Also in 2011, building upon experience of RiTe and with learning outcomes suitable for level 5 (year 2) students, RiTe II was piloted with a group of level 5 volunteer radiography students. As a direct consequence of RiTe II, there has been the collobrative working with radiography students in sante Lausannè, Switzerland to further evaluate the methodology and research conducted as part of RiTe II.[18]

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References

1. King T, Paterson P. Problem-based learning in higher education: theory into practice. In: Draft paper presented at the Higher Education Research and Development Society of Australasia (HERDSA) conference: quality conversations. Perth W. Australia: 7–10 July 2002.
2. Griffiths R. Knowledge production and the research-teaching nexus: the case of the built environment disciplines. *Studies in Higher Education* 2004;**29**(6):709–26.
3. Jenkins A, Healey M. *Institutional strategies to link teaching and research*. York: The Higher Education Academy; 2005.
4. Gibson DJ, Davidson RA. Exposure creep in computed radiography: a longitudinal study. *Academic Radiology* 2012 Apr;**19**(14):458–62.
5. Higgins R, Hogg P, Robinson L, Newton-Hughes A, Burton N, Cheetham M, et al. The RITE project: towards a research-led curriculum in a diagnostic radiography degree. *Synergy* 2011 July:26–8.
6. Brown SC, Stevens Jr RA, Troiano PF, Schneider MK. Exploring complex phenomena: grounded theory in student affairs research. *Journal of College Student Development* 2002 March/April;**43**(2):1–11.
7. Mills J, Bonner A, Francis K. The development of constructivist grounded theory. *International Journal of Qualitative Methods* 2006 March;**5**(1):2–9.
8. Strauss A, Corbin J. *Basics of qualitative research: grounded theory procedures and techniques*. Newbury Park, CA: Sage Publications; 1990.
9. Glaser B, Strauss A. *The discovery of grounded theory*. Chicago: Aldine; 1967.
10. Oates C. The use of focus groups in social research. In: Burton D, editor. *Research training for social sciences*. London: Sage Publications; 2002.
11. Kirklees Council. Research and consultation guidelines: focus groups. [On-line]. Available from: consultation@kirklees.gov.uk [accessed 4.07.12].
12. Denscombe M. *The good research guide for small-scale social research projects*. Buckingham: Open University Press; 1999.
13. Institute for Clinical Evaluative Sciences (ICES). Technical report: focus groups in health sciences at the Institute for Clinical Evaluative Sciences; May 1999. Pub. no. 99-02-TR.
14. Bandolier. Selection bias. [On-line]. Available from: http://www.medicine.ox.ac.uk/bandolier/booth/glossary/selectbi.html [accessed 14.08.12].
15. Polonsky MJ, Waller DS. *Designing and managing a research project: a business student's guide*. London: Sage Publications; 2005.
16. Strudwick RM, Mackay SJ, Hick S. Team working in diagnostic radiography: choreography or chaos? *Synergy* 2012 July:19–24.
17. Cheetham M, Falzon M and Fradley S. The RITE project experiment. Poster presented at UK Radiological Congress; 2011.
18. Norton S, Hogg P, Higgins R, Robinson L, Mackay S, Norton E, et al. Further developments in a research-led diagnostic radiography curriculum. *Synergy* 2012 September:20–3.

PAPER 3:

AN EVLUATION OF THE STUDENT AND TUTOR EXPEREINCE OF A RESIDENTIAL SUMMER SCHOOL EVENT (OPTIMAX)

An evaluation of the student and tutor experience of a residential summer school event (OPTIMAX)

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An evaluation of the student and tutor experience of a residential summer school event (OPTIMAX)

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ABSTRACT

Aim: To explore the experiences of students and tutors who participated in a residential multi-cultural and multi-professional 3 week summer school event (OPTIMAX).
Method: A grounded theory approach was adopted. Two semi-structured focus group interviews (student and tutor) were conducted to explore participant experiences. Both focus groups were audio recorded and then transcribed and coded to identify the main themes and draw conclusions.
Results: Inductive coding defined categories and sub-categories to explore the relationships within and between the two sets of focus group data.
Discussion: OPTIMAX was seen a positive experience by both students and tutors and provided an opportunity to undertake team learning with peers from different countries or professional backgrounds. However, consideration needs to be given to team size and tutor leadership.
Summary: By participating with international collaborative projects such as this, there is an opportunity to develop learning and explore current practices within radiography.

Introduction

European funding was acquired to subsidise a 3-week Erasmus Intensive Programme residential summer school, which was held at the University of Salford during August 2013. An Erasmus Intensive Programme is a short programme of study which brings together students and staff from higher education institutions from participating countries in order to[1]:

- Encourage efficient and multinational teaching of specialist topics which might otherwise not be taught at all, or only in a very restricted number of universities;
- Enable students and teachers to work together in multinational groups or teams and so benefit from special learning and teaching conditions not available in a single institution, and to gain new perspectives on the topic being studied;
- Allow members of the teaching staff to exchange views on teaching content and new curricular approaches and to test teaching methods in an international classroom environment.

Fifty four students and 13 tutors from the UK, Switzerland, Norway, Portugal and the Netherlands took part; they comprised radiographers, nuclear medicine technologists, pharmacists, biomedical scientists and medical/general physicists (see guest editorial in this special issue). The aim of the summer school was to bring together undergraduate and postgraduate students as well as tutors from participating countries in order to undertake multi-cultural and multi-professional team learning. The summer school was given the acronym of OPTIMAX as it explored approaches that might be used to minimise X-radiation dose in the clinical setting whilst preserving medical image quality. This is a key area of practice within radiography, as it is important to have the requisite knowledge and clinical decision-making skills available to be able to generate images that are diagnostic, whilst ensuring that all patient radiation doses are kept to a minimum.

Tutor responsibilities were defined and included in a written handbook to help them understand their role and to ensure that appropriate support, direction and guidance were given during the summer school. Additionally a 30 min support meeting was held for tutors each morning. Students were placed into 6 diverse multi-cultural and multi-professional collobrative learning teams of 9 students each, with 1 or 2 tutors per group. Each team undertook inquiry-based learning to explore a particular concept linked with the optimisation of x-radiation dose and image quality.

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It was envisaged that OPTIMAX would enrich participant knowledge of healthcare and medical imaging in other countries, extend international knowledge and awareness of staff and tutors and allow members of the teaching staff to exchange views on the teaching content. It was also an opportunity to develop institutional collobrative relationships in order to conduct further work beyond the life of the summer school. There has been a growing emphasis on the need for radiographers to engage with evidence based practice not only to fulfil continuing professional development responsibilities, but to also raise the profile of research within the profession itself.[2,3] Collaboration between clinical and academic centres has increased research productivity in other professions and has also been suggested as a strategy for radiography. OPTIMAX provided an opportunity for participants to network and share experiences with one another, possibly leading to the generation of further partnership working afterwards.[3] Learning activities undertaken during OPTIMAX built upon the experience gained from the Research-informed Teaching experience (RiTe). Within RiTe, undergraduate year 1 diagnostic radiography students at the University of Salford explore key areas of practice, namely deriving the relationships between image quality (perceptual), dose area product (DAP) and kVp.[4,5] However, for year 2 students RiTe has been developed with more academic rigour and students estimate effective dose rather than DAP using Monte Carlo mathematical modelling and along with a more robust method of perceptual measures for image quality. A number of socio-cultural activities were also organised to facilitate group cohesion.

Learning in small groups or teams has become a regular part of the student experience due to the rapidly expanding recognition that learning takes place through active participation in group processes.[6] Collaborative learning in small teams allows students to socially construct their knowledge through investigation as well as negotiating amongst themselves meanings in order to reach a consensus or agreement on a particular topic, particularly with limited but open-ended tasks.[3] However, leading successful group learning does not always come naturally to many tutors who may fall back on a reserve position of authority, expert and prime talker. Tutor skills in leadership, and facilitating a clear and coordinated strategy, are important factors for effective team working and learning.[7]

Given that this was such a unique event involving tutors and students from a number different European countries and professional backgrounds, it was decided to explore the multi-cultural and multi-professional experiences and perceptions of OPTIMAX by both the students and tutors. In addition it was hoped that recommendations to optimise preparation and support for similar events would be generated.

Method

Grounded Theory was selected as an interpretative and qualitative method to explore this phenomenon. Grounded Theory is an inductive, theory discovery methodology that provides the researcher with greater freedom to explore the research area and allow issues to emerge via the reconstruction and interpretation of empirical observations or data, and provides rigorous insight into areas unknown by the researcher.[8]

Two focus group interviews were used, one for students and another for tutors to explore their personal accounts, perceptions and experiences. The focus group interviews were held on separate days and convened in the final week in order to gain insights into the student and tutor experience of OPTIMAX and to elicit information that may not have become apparent during a survey or with one-to-one interviews.[9,10] The researcher acted as 'moderator' and used a semi-structured questionnaire to guide the discussion (Fig. 1). This enabled participants to share their experiences with each other and helped to identify any degree of consensus or differences of opinion between group members, as well as facilitating the triangulation of results between both focus group interviews.[9]

Ethical approval

University ethical approval (HSCR13/39) was granted prior to recruiting students and tutors to participate in the focus group. Good ethical practice for conducting focus groups was followed. This included the use of informed consent, participant information sheets and focus group guiding principles. All participants were assured of confidentiality and anonymity during and after the focus groups and were free to withdraw from either focus group at any point.

Sampling and recruitment

A stratified and purposive sampling approach was used in recruiting students and tutors to participate in the focus group interviews. All nationalities and professions from the summer school were asked to take part and all participants shared a common characteristic, in that they had experienced OPTIMAX either as a student or tutor. It was hoped to have at least one (preferably two) student/s from each team randomly selected from the volunteer cohort for the student focus group interview. Similarly, it was anticipated that there would be one representative from each team for the tutor focus group interview. Both tutors and students were made aware of the evaluation prior to attending and during the induction for OPTIMAX. Students and tutors were contacted by the researcher with an information sheet and asked to voluntarily take part in the focus group interviews.

Data collection

Seven of the 10 students who had originally volunteered, participated in the student focus group interview. Three students declined as they no longer wanted to take part. For teams 1 and 6 there were no student representatives, whilst teams 4 and 5 had 1 student representative each and teams 2 and 3 had 3 and 2 student representatives respectively. For the student focus group interview all the participants were radiography students and represented Norway (2), UK (1), Portugal (1), Netherlands (1) and Switzerland (1). For the tutor focus group interview there were 5 participants with no representative for group 6, representing the UK (2) (1 × PhD student from Iraq, dual qualified as a radiographer and physicist; 1 × PhD student from Iran, biomedical scientist), Switzerland (1) (nuclear medicine technologist) and Portugal (2) (both radiographers).

Data was collected using a digital audiotape to record both focus group interviews. Field notes were also taken to provide a permanent record of the researcher's interpretation of what was discussed and to act as point of reference during the data analysis.[5] Each focus group interview explored the participants' experiences, attitudes and perceptions of the summer school and lasted approximately 60 min. All responses were recorded anonymously as each student or tutor was randomly assigned a participant number (1–10 for students and 1–6 for tutors) and asked to state their number before speaking. There were no participant withdrawals during or after either focus group.

Data analysis

Each focus group interview recording was transcribed verbatim and analysed using QSR NVivo version 10. Field notes were also

1. From arriving on day one until now, can you think about your experiences of Erasmus / OPTIMAX.

   [For example what was good, and what was bad about the event]

2. What helped you to learn during Erasmus / OPTIMAX?

3. Were there any challenges? And if so were there solutions?

4. Did you identify any [multi-cultural/professional] aspects that you valued most during your Erasmus / OPTIMAX group work / learning / expereince?

5. Discussion around questions 1-4 → clarification and examples of these from participant experience

6. Any points for further discussion

Figure 1. Student and tutor experience semi-structured focus group questions.

included as part of the analysis following transcription. Each set of data was segmented into meaningful analytical units and inductive coding was then used to derive categories linked with the participant responses. Thematic analysis was used to synthesise the data and helped to identify any reoccurring categories relating to the student and tutor experience. Further analysis was undertaken to triangulate each category identified with the focus groups to explore whether there were any common relationships with the results obtained from both focus groups. Five common categories were identified for both focus groups, which were OPTIMAX event experience; group working; challenges; multi-cultural issues; multi-professional issues and OPTIMAX event structure.

Results

Both the student and tutor focus groups found OPTIMAX to have been a positive experience, with opportunities to not only learn more about image quality and dose, but to also learn from different cultures and professions:

> Student 10: *I think it's a great opportunity to get involved with something I wouldn't ordinarily do on my course*

> Tutor 1: *New horizons were opened up that may generate a new approach [to existing problems]*

The student focus group also highlighted the importance of the Welcome, social activities and presentations by students about their country held during OPTIMAX:

> Student 6: *I think it was very good to have something else [social events] organised rather than just learning activities*

> Student 8: *I think the presentations about the different countries [involved with OPTIMAX] were very important.... we now know a little more about these countries*

The student focus group identified the benefits of team working and how this had helped with their learning:

> Student 8: *Working in a team was a great experience in which to learn. I learnt a lot from the other students*

> Student 10: *I learnt a lot from peers in my team, because we are all at different [academic] levels, so it was great to meet with all of them and share ideas and ways of learning*

The tutor focus group participants also reported on student team working:

> Tutor 6: *My team worked hard [together] and now have some new skills*

> Tutor 2: *I was very pleased. The level of team work was fab!*

Both focus groups discussed the multi-cultural relationships of OPTIMAX. The student focus group saw this as an opportunity to improve their English and to share experiences with students from different countries:

> Student 8: *I think this is a great experience for us, so we can get to know people from other countries*

> Student 6: *I also learned how to communicate with people from different countries and to see what is important in different countries compared with my own country*

The tutor focus group also viewed this relationship in terms of team working:

> Tutor 4: *From a cultural point of view, my team had a number of different backgrounds … but I didn't find any conflicts within the team because of that*

> Tutor 3: *We are all in Europe, and I think it helped to enrich relationships … Another interesting point for me was that the way of doing things is slightly different from my school. In Switzerland we are much more pragmatic, you [UK] have a question and you go away and do the work*

Both focus groups also briefly discussed multi-professional relationships with regards to team working, learning and sharing knowledge or experiences:

> Student 6: *Not everyone was a radiography student in my team, so I was able to learn more about statistics from the physics student*

Tutor 1: *You gain some new knowledge especially from your colleagues and from the students also. People from different cultures and professions have their own approach to research, that is quite different from our approach and you can learn from them*

Both focus group interviews also identified a number of challenges as part of their OPTIMAX experience related to multicultural team working and learning:

Student 4: *Language barriers made some of the team members more defensive when using English. It also seemed confidence in the team was more prevalent with team members working with members from their own country*

Tutor 6: *I had some problems with communication as some of my students could not speak [fluent] English, so I needed to use three different languages with my team to translate concepts*

Another challenge expressed by the student focus group was the first week, which consisted of a week-long set of lectures to introduce the students to the background concepts of their OPTIMAX activity:

Student 4: *The first week was filled with a lot of lectures, and some of these were very long and at a high level academically*

Student 6: *For me personally, the challenges were the first few days of the lectures … it was a little bit difficult for me to follow all the lectures*

One of the tutors also raised this issue:

Tutor 2: *We had a data analysis session which took about 4 hours, which was really overwhelming for the students and myself*

The tutor focus group interview did raise the challenges of meeting time constraints and tutor support:

Tutor 4: *I don't think there was enough time. People ended up doing a lot of work outside the university, but I don't know if it possible to do it another way - I guess this is an intensive programme, it's very, very hectic, but I think the output will be excellent for sure*

Tutor 6: *Sometimes I felt a little bit disappointed not to have another tutor to discuss some points with, because I have some have younger students that don't have much [radiography] experience, so for them it is harder to share ideas*

Finally, both focus group interviews identified areas or made recommendations on how they thought that OPTIMAX might be improved. Interestingly, recommendations from both focus groups centred on lecture content and delivery:

Student 1: *I think that the lectures were too long … it would have been nice to have some lectures on how to do research and the different parts of a journal paper*

Tutor 4: *I think the lectures were too long … mine was too long, but my lectures run for ninety minutes and for me in my country [Portugal] this is the standard*

Team working dynamics, size and tutor involvement with regards to team working and learning were also discussed in both focus groups:

Student 5: *My team had eight students, but for me it was big team to do research with. I would have preferred to be have been involved with more of tasks, but I wasn't able to because of the team size*

Tutor 3: *… I also agree that it is not useful to have a second tutor for a short time. I think you really need two tutors for the whole 3 weeks*

The student focus group also suggested the commencement of team work earlier in week 1, rather than waiting until week 2:

Student 4: *The team work should have started earlier, because we have liked to worked more on our research*

Student 10: *We could have done more team work to break up [first week of] lectures*

Another issue raised by the both focus groups was the lecture content, especially with regards to undertaking and writing a research presentation:

Student 6: *Before I came here expected that we would have lectures about how to do research, what we should write in the conclusion and discussion and what is the best way to collect the results …*

Tutor 2: *The students wanted a presentation about research. I believe that we had a presentation about the errors in research by Z, which was really directed to the task. So probably, it is good to have something about how to write a paper, the different parts of the paper … this one thing that I think that we missed*

One student also raised a concern about the tutors lacking clarity about the research and how to involve students with the team work process:

Student 5: *I think … our tutor did not involve us so much in the research compared to the other tutors. Maybe they didn't understand our team or research topic*

One tutor also commented upon an earlier discussion with other tutors to address problems with the distribution and allocation of students within teams:

Tutor 4: *We discussed this earlier amongst ourselves, maybe on the first day we all need to get together and make a revision of the numbers and distribution of student teams. Then we have time to make some changes before the groups start working on their respective research topics*

Discussion

OPTIMAX was seen to be a valuable learning experience by both student and tutor focus groups. It provided students and tutors with the opportunity to explore the concept of image quality and dose optimisation within the field of medical imaging with peers from different cultures and professions. Students also cited the importance of collaborative team learning, whereby they socially constructed their knowledge through investigation and exploration within their teams.[11] This was also previously identified with work exploring the undergraduate student experience and perception of RiTe.[4,5]

However, consideration does need to be given with regards to team working and learning processes. The size of the team was seen as being an important factor for both students and tutors with regards to learning and team participation. From the student focus group it was suggested that smaller team sizes would enable a

greater sharing of tasks. Although with larger teams it is difficult to ensure that all members of team participate with all activities, small teams of 3 may contain less diversity and lack divergent thinking (Fig. 2).[6] It is also important to ensure that the tutors involved with these types of events understand the purpose of the research and facilitate team based activities. This is in order to ensure that each member of the team is involved with the process. Although, the literature is inconclusive about whether the best tutors are subject experts (and indeed it may be difficult to define what 'expertise' means within a multidisciplinary setting such as this), there are differences with how an expert and non-expert tutor may facilitate team working and learning. For example, the subject expert tutor may initiate more topics for discussion and raise awareness of the topic, whilst the non-expert may encourage students to challenge each other or use team facilitation techniques more often.[12] A consideration therefore might be in having 1 tutor who has an in depth knowledge of the topic for research and another non-expert tutor to monitor and facilitate the team work activities.

From the student focus group there was also an expectation by students that there would be some formal direction on how to conduct the research and resources on how to write/format a research report. This was also acknowledged by one of the tutors as an area that was missed and maybe needed to be included for future events. Both student and tutor focus group identified that they felt the length of lectures were too long. In a study undertaken Bryner[13] explored learning as a function of lecture length, and found that a 20 min lecture was equal to a 50 min lecture in terms of the amount of information retained by students, therefore suggesting a need to re-evaluate the length of lectures given in order the efficiency of teaching and student learning. Carrell, Dunkel and Mollaun[14] identified that students performed best during short lectures (especially when combined with note taking) and performed less well during long lectures. Although, it is difficult to ascertain what an 'ideal' lecture length might be (anecdotal discussion from the tutor focus group interview suggested that this might be 30–40 min). It is widely accepted that a teacher centred approach is not always a highly effective means of helping students to achieve learning outcomes. Student centred learning may be difficult to achieve given the complex nature of some the topic material. One method to overcome this problem might be a team-based approach to learning. Students work in teams and undertake online work of a given topic prior to their attendance at the summer school. The students in their teams then relay their understanding of the topic back to other students. The lecturer can then monitor progress and understanding of the topic material delivered by the students. Alternatively, lectures could be given in 10–15 min segments punctuated with varied or alternated activities (e.g. problem solving) to encourage a more active learning approach.[15]

Multi-cultural and multi-professional differences did not appear to impact negatively on the experience according to both focus groups, although problems with language barriers and being able to express or explain concepts in English were reported. This influenced the completion of tasks within the allotted time scales. For example, a tutor reported that they needed to translate a number of concepts or ideas into 3 different languages which may have resulted in less time to undertake some tasks set for that day. Both students and tutors stated that they had become more aware of and gained a better understanding of other cultures and professions. Interestingly, some students saw an advantage of having a member of their team with a different professional background from their own in order to facilitate the analysis of results (e.g. having someone who has knowledge of analysing and presenting data, such as a physicist for example).

Both focus groups identified areas that they felt made their experience challenging. For instance, a number of recommendations were suggested by both focus groups such as beginning the group working earlier, ensuring lectures are relevant and to a suitable level and that there should be two tutors per team to help facilitate the process and support one another. The social events which had been organised were also well received and seen as integral part of galvanising students and tutors together. Recommendations for improvement are summarised in the next section.

Limitations of this evaluation include the fact that not all student and tutor groups were represented and therefore this may have biased the results. Another limitation of the student focus group was that despite being from different countries, they were all from the same professional background (radiography). However, it is hoped that further work may be undertaken to explore multi-cultural and multi-professional team learning within a similar context (medical imaging research). Finally, all thematic coding was performed by a single researcher which may have resulted in interpretative bias. For future work it is proposed to work with another researcher and compare impressions from individual observations.

Number of members	Changing characteristics
2-6	Little structure or organisation required; leadership fluid
7-12	Structure and differentiation of roles begins; face-to-face interaction less frequent
13-25	Structure and role differentiation vital; sub-groups emerge; face-to-face interaction more difficult
26-?	Positive leadership vital to success; sub-groups form; greater anonymity; stereotyping, projections and 'flight/fight' occur

↑ More cohesion ↓ More tension

Figure 2. Changing characteristics of groups with increase in membership (taken from Jaques and Salmon[6]).

Recommendations

Following evaluation of the findings from both focus groups, a number of recommendations are suggested for similar future events. These include having two tutors per team to ensure that all students have clarity about the primary objectives of the summer school and to facilitate team work and participation with tasks as well as supporting one another; acknowledging that tasks may take longer than expected with multi-cultural and multi-professional team working and therefore allow extra time where possible to ensure that tasks will be completed on time; the size of a team is important and should ideally be no more than 10 students (for example, within RiTe this was kept to 6–7 students per team) with at least two tutors per team to facilitate activities; alongside this team work activities should commence as early possible, preferably in the first week to help galvanize the students and tutors; lectures should be aimed at the appropriate level (undergraduate), not be too complex or unnecessarily long and if possible facilitate active learning using team-based learning or by using activities with in the lecture that require student interaction. Finally, Welcoming and social events are important as these help both students and tutors to network and promote communication with one another.

Summary

OPTIMAX was seen a positive experience by both students and tutors, especially with regards to collaborative learning with peers from different countries or professions from their own. However, it is important to recognise that there are a number of considerations to take into account when undertaking multi-cultural or multi-professional team learning, such as considering the size of the team. Another consideration is tutor leadership of team working to ensure that a clear and coordinated strategy is adopted in order to ensure that each member of the team takes part and shares responsibility for completing tasks so that they feel involved in the process. It may be beneficial to have 2 tutors per team – one to monitor learning (subject expert) and one to ensure team working or facilitation of tasks (non-expert).

Radiographers need to be more active in examining current practices and OPTIMAX attempted to provide a comprehensive and realistic experience of this. Innovative approaches such as this need to be considered as an opportunity to explore current practises with international higher education institutes (HEIs) or with other professionals. Funding has been awarded for a second residential summer school and recommendations identified from this evaluation will be employed in its delivery.

References

1. The British Council. Erasmus intensive programmes. Available from: [accessed 06.06.14], http://www.britishcouncil.org/erasmus-intensive-programmes.htm; 2014.
2. Reid K, Edwards H. Evaluating the role of the diagnostic research radiographer. *Radiography* 2011;**17**:207–11.
3. Snaith B. Collaboration in radiography: a bibliometric analysis. *Radiography* 2012;**18**(4):270–4.
4. Higgins R, Hogg P, Robinson L. Integrating research-informed teaching within an undergraduate level 4 (year 1) diagnostic radiography curriculum: a pilot study. *J Vocat Educ* 2013;**65**(3):351–68.
5. Higgins R, Hogg P, Robinson L. Towards a research informed teaching experience within a diagnostic radiography curriculum. The level 4 (year 1) student holistic experience. *Radiography* 2013;**19**:62–6.
6. Jaques D, Salmon G. *Learning in groups: a handbook for face-to-face and online environments*. 4th ed. New York: Routledge; 2007.
7. Bruffle KA. *Chapter two: consensus groups: one kind of classroom collaboration in collaborative learning*. 2nd ed. Baltimore: The Johns Hopkins University Press; 1999.
8. Jones M, Alony I. Guiding the use of grounded theory in doctoral studies – an example from the Australian film industry. *Int J Dr Stud* 2011;**6**:95–113.
9. Denscombe M. *The good research guide for small-scale social research projects*. Buckingham: Open University Press; 1999.
10. Kirklees Council. *Research and consultation guidelines: focus groups [On-line]*; 2014. Available from: http://www.kirklees.gov.uk/community/yoursay/Focus_groups.pdf [accessed 7.02.14].
11. Vygotsky LS. *Mind in society: the development of higher mental processes*. Cambridge: Harvard University Press; 1978.
12. Dolmans DHJM, Gijselaers WH, Moust JHC, DeGrave WS, Wolfhagen IHAP, Van Der Cleuten CPM. Trends in research on the tutor in problem-based learning: conclusions and implications for educational practice and research. *Med Teach* 2002;**24**(2):173–80.
13. Bryner CL. Learning as a function of lecture length. *Fam Med Jun* 1995;**27**(6):379–82.
14. Carrell P, Dunkel PA, Mollaun P. Effects of notetaking on listening comprehension. *Comprehension* 2004;**14**(1):83–105.
15. Center for Instructional Technology. *Lecturing and active learning [online]*; 2014. Avilable from: http://cit.duke.edu/get-ideas/teaching-strategies/active-learning/ [accessed 12.06.14].

PAPER 4:

INTERGRATING RESEARCH-INFORMED TEACHING WITHIN AN UNDERGRADUATE DIAGNOSTIC RADIOGRAPHY CURRICULUM: RESULTS FROM A LEVEL 4 (YEAR 1) COHORT A

University of Salford MANCHESTER

Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum : Results from a level 4 (year 1) student cohort

Higgins, RN, Robinson, L and Hogg, P

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Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: Results from a level 4 (year 1) student cohort

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ABSTRACT

Aim: Previously we reported on focus group research which explored the level 4 (year 1) student experience of the Research-informed Teaching experience (RiTe). This article discusses follow up research with a new student cohort.
Method: An online questionnaire was used to explore the level 4 student cohort experience of RiTe. A Multi-method approach was taken to analyse the data, identify themes and link questionnaire findings with those from the focus group research.
Results: A 54% (27/50) response rate was achieved. Students found RiTe to be a positive experience and there was strong agreement that it had increased their knowledge of research methods and understanding of key areas of practice.
Conclusions: Results from the questionnaire supported the focus group findings. One of the key factors in the success of RiTe was that of collaborative learning. This was achieved by the students undertaking an inquiry and situated approach to learning within small groups.

Introduction and background

The Research-informed Teaching experience (RiTe) integrates research and teaching within the undergraduate diagnostic radiography curriculum at the University of Salford. RiTe was developed to help create a greater understanding of research at undergraduate level, improve learning of key areas and assist in the development of clinical decision-making skills using a student-centred and simulated scenario approach. Previously, we reported on focus group research which explored the level 4 (year 1) undergraduate diagnostic radiography student experiences of RiTe.[1] Within RiTe, students explore key areas of practice suitable to level 4 teaching and learning outcomes; namely deriving the relationships between image quality (perceptual), dose area product (DAP) and kVp.[1,2] RiTe also encourages students to undertake research that is relevant to their development as first post radiographers.

Although, there was no formal requirement to evaluate the student experience of RiTe, many educators view this an important factor in understanding student learning and development.[3] Results from our focus group research demonstrated that the students found RiTe to be a valuable and worthwhile learning experience, especially with regards to facilitating their understanding of research methods and the relationship between image quality with kVp and DAP.[1]

In this paper we report follow up research which was undertaken using an online questionnaire. The purpose of this was to further explore the student experience and perception of RiTe using a different level 4 student cohort to that who participated in the focus group research. In the discussion we consider the questionnaire results and contextulaise them with the previously published focus group research.

Method

An online questionnaire was used to collect data to explore the whole level 4 student experience of RiTe. The questionnaire was created using the Bristol Online Surveys (BOS) website (http://www.survey.bris.ac.uk/).

Pilot

A pilot of the questionnaire was circulated both to the level 4 students and selected members of the academic team in order to

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determine clarity of the questionnaire, appropriateness of the questions, potential for bias and ease of completion.[4] Questionnaire reliability was ensured, by reverse-wording some of the closed choice questions to minimise acquiescence bias (the tendency for participants to respond indiscriminately to questions).[5] No issues were identified.

Instrument design

The questionnaire design was informed by the themes identified from the previous focus group research.[1] The questionnaire concentrated on the five key themes identified from the focus group, with an open comments section at the end:

1. Student awareness of research-related activity
2. Student experience of RiTe
3. RiTe and the curriculum
4. RiTe and clinical skills development
5. RiTe and research skills development

A combination of open and close ended questions were used within each section of the questionnaire (apart from the general comments section which was open ended only). For the close ended questions, a five point Likert rating scale was used to ascertain the extent to which students either agreed or disagreed with each question (Fig. 1). Open ended questions (via a free text box option) allowed students to comment further upon their answers. This allowed for more depth to be added to the questionnaire by eliciting the reasons for their choice of agreement or disagreement to each question.[5]

Sampling and recruitment

All level 4 students who had undertaken RiTe were contacted by the undergraduate Diagnostic Radiography programme leader with an information sheet about the research and asked to voluntarily participate with the research. This was a different level 4 student cohort to that used with the focus group research. Students accessed the questionnaire via a user resource link (URL). This was made available via the Blackboard e-Education student learning platform. The online questionnaire was made available to the students for 10 weeks before being closed for data collection. During this time 2 reminders were sent out to invite students to participate with the research.

University of Salford ethical approval (HSCR12/12) was granted and good ethical practice for questionnaire administration and analysis was followed, with consent assumed to be implied with completion of the questionnaire. However, students could withdraw at any time by exiting the questionnaire. Any data arising from incomplete questionnaires was excluded from the results. Students were assured of confidentially and anonymity during and after the questionnaire.

Data analysis

Descriptive and thematic analysis was used to explore the data. Thematic analysis was also was used to synthesise the data from the open choice statements; this helped to identify any reoccurring categories relating to the same phenomena found with the previous focus group research. This would help with the triangulation of these relationships with the results obtained from the focus group data.

Results

The questionnaire response rate was 54% (27/50). Acceptable response rates for questionnaires/surveys vary according to their method of distribution. For a paper questionnaire a completion rate of 50% is considered adequate with a 60% completion rate thought to be the ideal.[6] Conversely, for an online questionnaire an acceptable completion rate is around 30%.[6] Key findings are summarised below:

Departmental research-related activities seen by students to contribute towards their learning on the radiography programme

Students were asked to identify activities (more than one response was permitted), which they thought contributed towards to their learning. Research seminars held by the department along with books or articles published by staff were seen as contributing the most by students at 27%, with research posters in the department seen as contributing the least (9%) (Fig. 2).

Student experience of RiTe

There was strong disagreement (96%) by students with the statement 'I did not learn anything during RiTe'. 58% of students disagreed with the statement 'I did not understand what was expected of me during RiTe', with 55% of students also disagreeing with the statement 'I felt that I did not have enough time to complete the activities within RiTe' (Fig. 3). Students commented that:

'Overall I felt RiTe was a good experience into how to do research and I know some areas that I need to develop further, such as data analysis…'

'I enjoyed [RiTe] overall and found it useful'

'More time would have lead to more in depth research but the time was about right for the study conducted'

There was strong agreement (78%) with the statement 'I found RiTe to be an enjoyable and stimulating learning experience' and with the statement 'I enjoyed working as part of a group/team during RiTe' (85%) (Fig. 4). Students commented that:

'Good team and worked together to achieve the goals'

'Great team work- learnt from my peers'

'Working within a group I felt comfortable in'

'Learnt to get to know some of the other members in the group better'

There was strong agreement (74%) by students with the statement 'I enjoyed being self-directed in my learning'. One student commented further on this aspect of their experience:

'I enjoyed investigating and working things out for myself instead of being told how things work'

There was also strong agreement (70%) by students with the statement 'I found the level of supervision/tutorial support to be about right'. Student comments related to this included:

'Having sessions lead by the PhD students was greatly encouraging and beneficial'

'The small tutorials given by PhD students were really helpful. They helped me to understand simple principles that I had struggled with previously'

'…Having the PhD students to assist was a good idea!'

'I found both the PhD students to be exceptionally professional with excellent teaching skills. I achieved a thorough understanding of SNR (signal to noise ratio) and contrast during the tutorials…'

Section 1. Student Awareness of research related activity
a. Which of the following research-related activities contribute towards your learning on the Radiography programme?
b. Research seminars:
c. Books or articles published by staff:
d. Research posters on display within the department:
e. Ongoing radiography research within the University:
Section 2. Student experience of RiTe
a. I did not learn anything during RiTe:
b. I found RiTe to be an enjoyable and stimulating expereince:
c. I enjoyed being self-directed in my learning during RiTe:
d. I found the level of supervision and tutorial support during RiTe to be just about right:
e. I enjoyed working as part of a group / team during RiTe:
f. I did not understand what was expected of me during RiTe:
Section 3. RiTe and curriculum
a. I can see the relevence of RiTe within the diagnostic radiography curriuclum:
b. I feel that RiTe has helped me to understand what I have been taught and apply this in clinical practice:
c. I do not see RiTe as having any benefit as part of my teaching and learning within the curriculum:
d. I feel I have gained a greater appreciation of the role of research within radiography:
e. I feel that RiTe has helped me to develop my critical questioning skills:
f. I feel that by particpating with curriculum activities such as RiTe, my employability will be enhanced:
Section 4. RiTe and clinical skills development
a. I feel able to apply the knowledge gained from RiTe within my clinical environment:
b. I feel that RiTe has helpled me to develop my clinical skills further:
c. I feel more confident in the assessment of image quality:
d. I feel that what I have learned within RiTe will have a positive effect on my patients:
e. I feel able to share the knowledge gained from RiTe with other Radiographers:
f. I feel able to share the knowledge gained from RiTe with my peers (Other Radiography students):
g. I feel able to share the knowledge gained from RiTe with other health professionals (e.g. Nursing staff):

Figure 1. RiTe student experience online questionnaire.

Section 5. RiTe and research skill development
a. I feel I have gained an increased awareness of the methodological issues associated with research:
b. I did not feel that RiTe helped me to develop my research skills:
c. I found the research within RiTe to be stimulating and interesting:
d. I feel that being able to use research skills are an important part of my career development:
e. I feel that the research undertaken within RiTe has helped me to understand the topic material better (the influence of exposure factors on image quality and DAP):
Section 6. General comments
a. What (if anything) helped your learning and/or research skill development during RiTe?
b. What (if anything) hindered your learning and/or research skill development during RiTe?
c. Any other comments?

Figure 1. (*continued*).

RiTe and the diagnostic radiography curriculum

Students strongly agreed (92%) with the statement 'I can see the relevance of RiTe within the diagnostic radiography curriculum', with 84% also agreeing with the statement 'I feel that RiTe has helped me to understand what I have been taught and apply this in clinical practice'.

There was strong agreement (82%) by students with the statement 'I feel that I have gained a greater appreciation of the role of radiography research', and similarly there was strong disagreement (85%) with statement 'I do not see RiTe as having any benefit as part of my teaching and learning within the curriculum' (Fig. 5). Comments made by students included:

'I have gained a better understanding of exposure factors and their relationship…'

'I enjoyed gaining practice at research and being guided through the process'

'[RiTe] helped me to understand simple principles that I had struggled with previously'

'[RiTe] gave me practice at research, and guidance through the process'

Sixty seven percent of students agreed with the statement 'I feel that RiTe has helped me to develop my critical questioning skills', with just over half (55%) also agreeing with the statement 'I feel that by participating with curriculum activities such as RiTe, my employability will be enhanced'.

RiTe and clinical skills development

There was strong agreement (74%) by students with the statement 'I feel able to apply the knowledge gained from RiTe within my clinical environment', with 66% also in agreement with the statement 'I feel that RiTe has helped develop my clinical skills further'. There was 67% agreement by students with the statement that 'I feel more confident in the assessment of image quality', and strong agreement (79%) with the statement 'I feel that what I have learned within RiTe will have a positive effect on my patients'.

Fifty one percent of students agreed with the statement 'I feel able to share the knowledge gained from RiTe with other radiographers [i.e. qualified radiographers]', with 37% of students neutral in their response to this statement. Similarly, there was 52% agreement by students with the statement 'I feel able to share the knowledge gained with other health professionals (e.g. nursing staff) with 33% of students responding neutrally to this statement. However, there was strong agreement (82%) by students with the

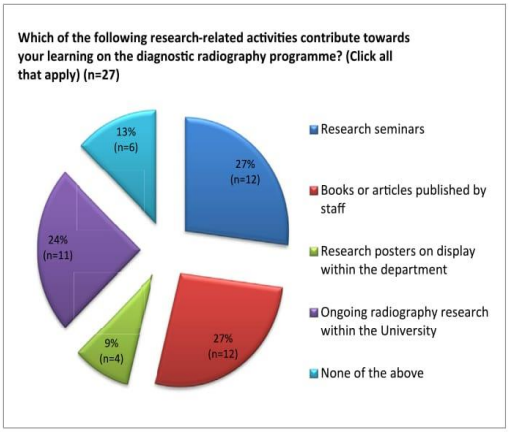

Figure 2. Pie chart of departmental research-related activities seen by students to contribute towards their learning on the radiography programme at the University of Salford.

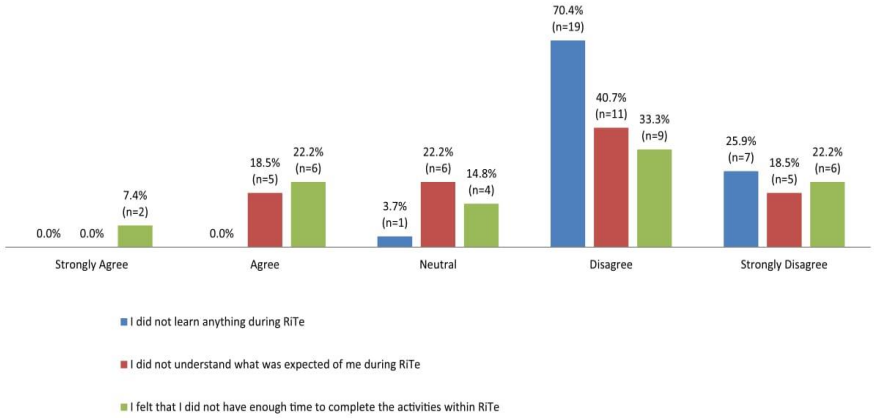

Figure 3. Student experience of RiTe (1) ($n = 27$).

statement 'I feel able to share the knowledge gained from RiTe with my peers (Other radiography students)' (Fig. 6).

RiTe and research skill development

For the final part of the questionnaire, there was strong agreement (78%) by students with the statement that 'I feel I have gained an increased awareness of the methodological issues associated with research'. Similarly, there was strong disagreement (93%) with the statement that 'I did not feel RiTe helped me to develop my research skills'. 71% of students also strongly agreed with the statement 'I found the research within RiTe to be stimulating and interesting'. Students commented that:

> 'Overall I felt it [RiTe] was a good experience into how to do research and I now know some areas that I need to develop further, such as data analysis…'
>
> 'I would have liked a summary by staff at the end of the week of what they think we should have learnt'
>
> 'I did not fully understand what was expected of us when presenting our findings'

There was strong agreement (82%) by students with the statement 'I feel that being able to use research skills are an important part of my career development' and again (89%) with the statement 'I feel that the research undertaken with RiTe has helped me to understand the influence of exposure factors on image quality and Dose Area Product (DAP)'. 71% of students also strongly agreed with the statement that 'I would like to have more involvement with research within the university'.

Discussion

Results from the previous focus group research demonstrated that students found RiTe to be a valuable, relevant and interesting learning experience.[1] Data gained from the online questionnaire further corroborated and supported the findings from the focus group research. Both sets of research data confirmed that students felt RiTe had helped to facilitate their understanding and knowledge of the effects of manipulating kVp on image quality and DAP, as well as increasing their awareness of the role of research within radiography and developing their research skills.

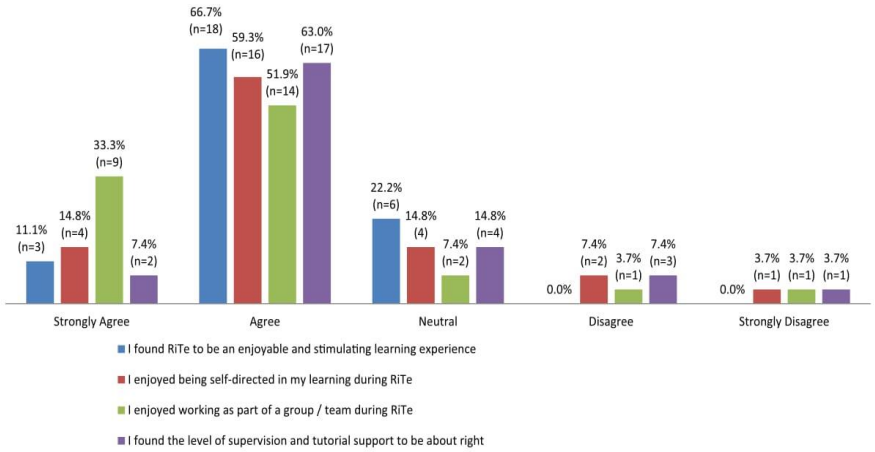

Figure 4. Student experience of RiTe (2) ($n = 27$).

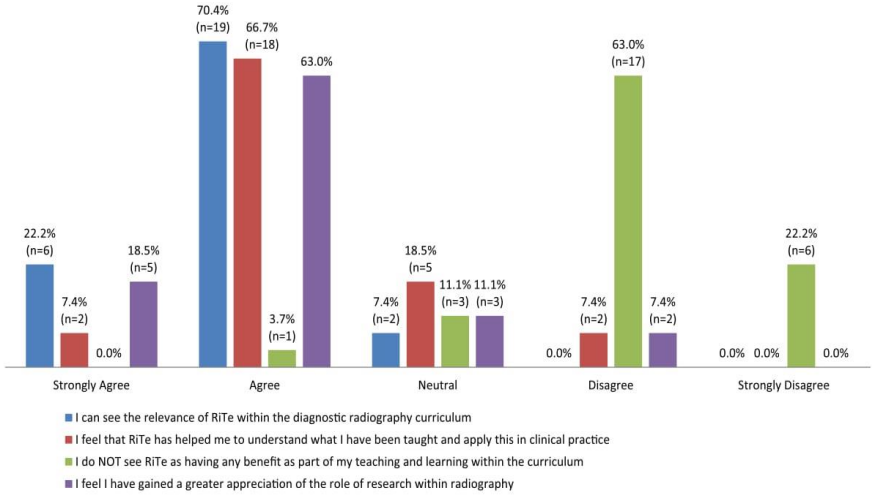

Figure 5. RiTe and the curriculum ($n = 27$).

One of the key elements identified by both the focus group and questionnaire data was that of collaborative learning by the students during RiTe. This was achieved by the students undertaking their learning within small groups. This approach is supported by Vygotsky's learning theory of social constructivism, which suggests that learners socially construct their knowledge through investigation and exploration within small groups.[7] However, small groups of three may contain less diversity and lack divergent thinking which helps with collective thinking and experience sharing. Alternatively, with larger groups it is difficult to ensure that all members participate (for RiTe, the group size was limited to no more than six students per group).[8] It has also been proposed that students often learn best through a process of knowledge construction, negotiation and refinement within a small group of peers. Peer group discussion helps to elicit multiple perspectives and encourages the negotiated construction of meaning. This process can be further enhanced by using situated learning or exploring practice relevant to the student's discipline.[9–11] This was something already incorporated within RiTe, whereby the students explored the relationships between image quality, DAP and kVp.

One of the key issues in encouraging students to undertake inquiry based learning activities, is challenging the mind-set of traditional learning (e.g. didactic teaching).[12] Both focus group and questionnaire data suggest that this was not a problem with RiTe. However, it must be acknowledged that this process may have been facilitated by the fact that the undergraduate programme already incorporates a hybrid Problem-Based Learning (PBL) approach to student teaching and learning. Therefore, the degree of student acceptability towards RiTe may have been different with a student cohort who had not previously experienced PBL.

One of the issues raised from the focus group research was that students felt unable to approach or discuss with qualified radiographers the knowledge they had gained during RiTe, for example, that increasing the kVp by small increments has little influence on image quality, but may result in an increased radiation dose to the patient (exposure creep).[13] From the questionnaire results 51% of students agreed that they felt able to share their RiTe knowledge with other qualified radiographers, but 37% were neutral. Similarly, 52% of students agreed that they felt able to share this knowledge with other health professionals, but again 33% gave a neutral

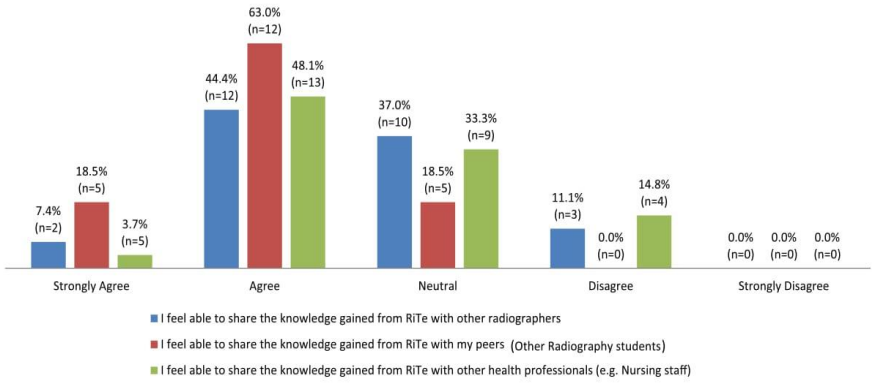

Figure 6. Knowledge sharing of RiTe ($n = 27$).

response. However, 82% of students agreed that they felt able to share this information with their peers (other radiography students). The reason for this is unclear, but may be due to a lack of confidence in expressing concepts such as exposure creep. Alternatively, student radiographers may feel disempowered in the clinical learning environment and unable to raise questions about radiographic practice, even where the evidence base suggests the practice is unsubstantiated. As identified within the focus group research, there could be a need to develop leadership skills at undergraduate level. Academic and clinical radiographers are being required to engage with research activity that seeks to reform and improve current practice. Without adequate training in leadership research, this activity may fail to flourish.[14,15] Various models of leadership are available, but the current model supported in the National Health Service (NHS) is transformational leadership, which enables change or transformation of people through motivation and empowering individuals. Leaders and followers are linked and therefore both change and transform as part of this process. This model could be adapted and utilised for the benefit for Radiography students.[16] Developing student leadership skills may also provide the impetus, once qualified as First Post Radiographers, for them to have the requisite skills to challenge traditional practices that may not necessarily be evidence based.[1]

Results from both the focus group and questionnaire also confirmed that the students were in favour of having more involvement with research as part of their teaching and learning experience; one of the objectives of RiTe is to make research methods more interesting to students. It is also hoped that RiTe will encourage students once qualified to use their clinical knowledge and research skills to develop evidence based practice (EBP) in order to support the development of Radiography as a profession and to ensure the highest quality patient care.

Recommendations

Recommendations based on the findings of both the focus group and questionnaire research include:

- Novel educational experiences that combine research and teaching (such as RiTe), can have a positive impact on undergraduate student learning with regards to developing essential clinical skills and providing insight into conducting and using research.
- Other programmes should consider adopting similar experiences into their curricula.
- However, they should be thoroughly evaluated to determine the student experience.
- Leadership skills have many values and the development of leadership skills in student radiographers should be considered within the curriculum.

Conclusion

Evidence from both the online student questionnaire and focus group research support RiTe as an acceptable pedagogical intervention to integrate research with teaching within the diagnostic radiography curriculum. RiTe uses a collaborative approach to learning, with students working in small groups exploring the relationships between image quality, DAP and kVp. Knowledge of these relationships is socially constructed by the students and shared within the group.

RiTe also helps to shape a more research active curriculum and so far has seen two fully successful embedded iterations. RiTe has been further developed and embedded into the level 5 (year 2) curriculum as RiTe II; this has now been delivered for the first time. Further research will explore the level 5 student experience of RiTe II.

References

1. Higgins R, Hogg P, Robinson L. Towards a research informed teaching experience within a diagnostic radiography curriculum. The level 4 (year 1) student holistic experience. *Radiography* 2013;**19**:62–6.
2. Higgins R, Hogg P, Robinson L, Newton-Hughes A, Burton N, Cheetham M, et al. *The RITE project: towards a research-led curriculum in a diagnostic radiography degree*. Synergy; 2011. July: 26–28.
3. Brown SC, Stevens Jr RA, Toroiano PF, Schneider MK. Exploring complex phenomena: grounded theory in student affairs research. *J Coll Student Dev* 2002;**43**(2):1–11. March/April.
4. McLeod PJ, Meagher TW, Steinert Y, Boudreau D. *Using focus groups to design a valid questionnaire. educating physicians: essays*. Academic Medicine; 2000. 75(6) June: 671.
5. Altermatt B. *Questionnaire & survey design: questionnaire design*. Available from, http://vault.hanover.edu/~altermattw/methods/assets/Readings/Questionnaire_Design.pdf; 2013 [accessed October 2013].
6. Instructional Assessment Resources (IAR). *Assess teaching: response rates*. Available form, http://www.utexas.edu/academic/ctl/assessment/iar/teaching/gather/method/survey-Response.php; 2013 [accessed July 2013].
7. Vygotsky LS. *Mind in Society: the development of higher mental processes*. Cambridge: Harvard University Press; 1978.
8. Rau W, Heyl BS. Humanizing the college classroom: collaborative learning and social organization among students. *Teach Sociol* 1990;**18**:141–55.
9. Boyle T. Constructivism: a suitable pedagogy for information and computing sciences?. In: *1st LTSN-ICS Annual Conference*. Edinburgh: Heriot-Watt; 2000.
10. Lave J, Wegner E. *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press; 1991.
11. Bruffle KA. *Chapter two: consensus groups: one kind of classroom collaboration in collaborative learning*. 2nd ed. Baltimore: The Johns Hopkins University Press; 1999.
12. Benson A, Blackman D. Can research methods ever be interesting? *Active Learn High Educ*; 2003:39–56. 4(1) March.
13. Ma WK, Hogg P, Tootell A, Thomas N, Kane T, Kelly J, et al. Anthropomorphic chest phantom imaging – the potential for dose creep in computed radiography. *Radiography* 2013;**19**:207–11.
14. Lee NJ, Gambling TG, Hogg P. Leadership in research. *Radiography* 2004;**10**:69–73.
15. Lovegrove M. Are radiographers prepared for the clinical leadership challenge? *Radiography* 2012;**18**:230–1.
16. Hendry AH. Are radiography lecturers, leaders? *Radiography* 2013;**19**:251–8.

PAPER 5:

CONSTRUCTIVE ALIGNMENT OF A RESEARCH-INFORMED TEACHING ACTIVITY WITHIN AN UNDERGRADUATE DIAGNOSTIC RADIOGRAPHY CURRICULUM: A REFLECTION

University of Salford MANCHESTER

Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum : a reflection

Higgins, RN, Hogg, P and Robinson, L

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Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: A reflection

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ABSTRACT

Aim: To evaluate the learning experience of a level 5 (year 2) student cohort within a research-informed teaching (RiT) activity and to map findings against learning outcomes and level descriptors using constructive alignment.

Method: An online questionnaire was used to explore the level 5 student experience of a Research-informed Teaching (RiT) activity. Responses were retrospectively mapped against Framework for Higher Education Qualifications (FHEQ) level descriptors for level 5 using constructive alignment.

Results and Discussion: Thirty one out of 46 level 5 students completed the questionnaire (67% response rate). Analysis of the questionnaire supported the integration of this RiT activity within the curriculum in terms of learning and research skill development by students. However, it was identified that this activity could be revised further to better align with level 5 descriptors and incorporate additional higher level cognitive processes.

Conclusion: Learning outcomes for this RiT activity were constructively aligned with FHEQ level 5 descriptors. Recommendations are provided on how these could be further refined to ensure students undertake a more critical approach to the application of theory into practice. Discussion also considers how this process could be used to develop a similar RiT activity at level 6 (year 3).

Introduction and background

Research-informed Teaching (RiT) has been shown to develop student research and communication skills as well as enhancing knowledge and understanding.[1] In 2009, the BSc (Hons) Diagnostic Radiography programme team at the University of Salford, United Kingdom (UK) introduced a level 4 (year 1) Research-informed Teaching (RiT) activity within the undergraduate diagnostic radiography curriculum to engage students with research, as part of their normal teaching and learning experience. The Research-informed Teaching experience I (RiTe I) was designed to facilitate level 4 student understanding of key radiographic concepts using an inquiry-based approach to learning and provided students with the opportunity to be involved with research linked with one of the department's main research foci (image quality and dose optimisation).[2–4] Following the successful integration of RiTe I into the year 1 curriculum, a similar RiT activity was introduced into the level 5 (year 2) curriculum (RiTe II). RiTe II directly builds upon the foundations of the student's knowledge and research skills obtained at level 4, as well as providing students with further learning and skill development opportunities appropriate to their level of study. The following reflective report illustrates the value of using constructive alignment to critically evaluate level descriptors and learning outcomes for a level 5 RiT activity (RiTe II); because this evaluation takes a reflective approach the pronoun 'we' is therefore used where appropriate.

In the UK and Ireland, each stage within any framework of qualifications is commonly referred to as a 'level'. These levels represent bands of qualifications that share similar expectations of attainment. The framework for higher education qualifications (FHEQ) has five levels, three of which are undergraduate (4–6) and

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two are postgraduate (7–8). The learning outcomes for RiTe I were designed to meet the FHEQ level descriptors for level 4 set by the Quality Assurance Agency for Higher Education (QAA).[5] Subsequent evaluations of RiTe I have confirmed the success of this activity.[2–4] However, in designing RiTe II we took a more pragmatic approach. Whilst we compiled a set of learning outcomes based on our own expectations of what we anticipated the students to achieve, we did not undertake a formal mapping process in matching these to level 5 descriptors, as RiTe II was considered to be a curriculum enrichment activity. Whilst it is acknowledged that there should be alignment between learning outcomes, delivery and assessment,[6] we decided that because RiTe II had no summative assessment there was no requirement to provide learning outcomes from an institutional documentation perspective. Furthermore, because there was no summative assessment for RiTe II, we had no method of determining whether the learning outcomes had actually been achieved.

Level descriptors

The QAA in the UK uses qualification level descriptors to provide a point of reference for the setting and assessing of academic standards in higher education. These threshold standards are used to develop programme learning outcomes to appropriate levels and content.[7] Level descriptors can therefore be considered to be generic outcome statements of what a learner is expected to have achieved at the end of a level of learning and were developed as a guide to the writing of learning outcomes for modules to ensure that these subscribe to a particular higher education level, a process that is essential for functioning within a credit framework.[8]

Level descriptors are presented in two parts, with the first part being a statement of outcomes (achievement of which is assessed) which a student should be able to demonstrate for the award of the qualification at that level. The second part of the descriptor is a statement of the wider abilities that a typical student would be expected to have developed. Typically, programmes leading to higher education qualifications (particularly those taken over a number of years such as radiography), include learning that is progressively more challenging. For the award of a higher education qualification at a particular level, the outcomes of this learning must reflect the qualification descriptor for that level.[9] For example level 4 students are expected to demonstrate *'Interpretation and evaluation of knowledge; structured communication and coherent argument'* within their area of study, whilst at level 5 a key characteristic or differentiator is the *'Critical understanding, analysis and evaluation of knowledge; application of outside its original context; communication and argument in a variety of forms'*.[5,7]

Learning outcomes

Learning outcomes are statements that are used to express what is expected that students should be able to do or demonstrate at the end of a learning period. There are various definitions of what is meant by a learning outcome, but it is agreed that learning outcomes focus on what the student has achieved and not just the content of what has been taught.[10,11]

Learning outcomes can be traced back to the *behavioural objectives* movement of the 1960s and 1970s in the United States of America (USA). A key advocate of this movement was Mager[12] who proposed writing specific statements about observable outcomes or *instructional objectives*.[10,12] By using instructional objectives and performance outcomes Mager[12] attempted to define the type of learning that would occur and how that learning would be assessed. Unfortunately, this can lead to outcomes and objectives (usually a specific statement of teaching intention or teacher centred approach) being used interchangeably or worse as a compound phrase (outcomes/objectives). This can cause problems in that objectives can be written in terms of teaching intention or in terms of expected learning which can cause confusion when developing modules or learning activities.[11] Although they both relate to the product of learning and have similar meanings with regard to educational intent, the use of terminology within learning outcomes emphasises student achievement and what should be learnt rather than taught.[11] Learning outcomes are therefore statements of what a learner is expected to know, understand and/or be able to demonstrate after completion of a process of learning.[10] Table 1 provides a comparison of learning outcomes and objectives.

Levels of outcome and taxonomies of learning

As discussed earlier level descriptors provide an indicator of demand, complexity, depth of study and learner autonomy required for the award of a qualification at given level or advancement to the next level. These add to the transparency and clarification of the learning process by providing a structure to guide progression in learning at different levels.[14] However, when writing learning outcomes it is important to consider that these are expressed at the appropriate level of learning and complexity.[7]

Bloom's taxonomy of educational objectives[15] is frequently used for writing learning outcomes. Bloom's taxonomy is considered a major work with regard to concern for levels of achievement as a statement of leaning outcomes and originally focused on the *cognitive* or *knowing domain of learning*. Bloom suggested that in this domain understanding ranged over six levels of learning from the lowest level (factual knowledge) to increasingly more cognitive tasks such as the evaluation of information.[15] At the lower cognitive levels, students have learning which relates to gaining knowledge and understanding. With greater conceptual and intellectual challenge levels, students learn to carry out the higher level activities of synthesis and evaluation. Bloom's taxonomy describes how learners can build upon former learning to develop more complex levels of understanding, by the arrangement of the various thinking processes in a hierarchy. Each level within this hierarchy depends on the student's ability to perform at the level or levels that are below it.[10] Anderson et al.,[16] revised Bloom's taxonomy by changing the names of the 6 domains from noun to verb forms or action words in order to promote a more active form of learning to facilitate students being able to demonstrate a learning outcome at the end of an activity (Table 2). These verbs can be used to help frame learning outcomes for different level descriptors (demonstration of higher order learning or achievement) by their use at the appropriate cognitive level. They also help to ensure that learning outcomes produce the result which is appropriate for the level of achievement intended.[14,15]

However, although Bloom's taxonomy is useful for planning and writing learning outcomes, it was criticised for excluding other domains of learning. Bloom and his co-workers extended the

Table 1
Comparison of learning outcomes and objectives using the research-informed teaching learning activity as an example (Adapted from Ref. 13).

Learning outcome	Equivalent learning objectives
At the end of this activity you will be able to demonstrate the effects of changing kVp and focal spot size with a fixed mAs on dose area product (DAP) and image quality.	At the end of this activity you should be able to: Describe the effects of changing kVp and focal spot size with a fixed mAs. Describe their effects on image quality and dose area product (DAP).

Table 2
Hierarchy of the cognitive domain and verbs appropriate to different levels. (Adapted from Refs. 12,13,19).

Level	Examples of appropriate verbs
6. Synthesis/Creation (*Advanced*)	Hypothesise, Design, Construct, Devise
5. Evaluation	Appraise, Argue, Assess, Conclude, Critique
4. Analysis	Analyse, Appraise, Classify, Compare
3. Application	Apply, Choose, Compute, Demonstrate
2. Understanding	Classify, Describe, List, Report, Discuss
1. Remembering (*Basic*)	Recognise, Identify, Define, Recall

taxonomy to include the *affective* and *psychomotor* domains. The affective domain is concerned with the emotional component of learning and ranges from basic willingness to receive information to the integration of beliefs, ideas and attitudes. The psychomotor domain emphasises physical skills involving co-ordination of the brain and muscular activity and is commonly associated with areas of learning such as health sciences, art, and engineering.[14,10]

Constructive alignment

When designing learning outcomes for an educational module or programme of teaching and learning these should be co-ordinated with the assessment task. Biggs[18] refers to this process as constructive alignment. The word constructive refers to the type of learning and what the learner does, with alignment referring to what the teacher does.[10] Biggs[18] states that traditional transmission theories of teaching ignore this alignment and that teaching, learning and assessment should all be co-ordinated to support student learning. There are three basic tasks involved in the constructive alignment process. These include clearly defining the learning outcomes, designing assessment criteria for students to demonstrate that they have met these and developing teaching and learning methods that are likely to ensure that the learning outcomes are achieved by meeting the assessment criteria[10] (Fig. 1).

Constructive alignment is student-centred in that it is what the *student does* that is responsible for their learning. The role of the teacher is to create an appropriate learning environment in order to engage the student in learning activities that enable them to meet the learning outcomes. As discussed previously Bloom's Taxonomy[15] is often used as a basis for categorising outcome statements according to the cognitive ability they elicit and can help with this alignment process.[20]

Learning outcomes for RiTe I (level 4)

Using Bloom's revised taxonomy as a framework, the learning outcomes for RiTe I were written in the cognitive domain. This was to ensure the demonstration of knowledge and appraisal of the underlying concepts and principles associated with exposure factor manipulation, image quality and measurements of Dose Area Product (DAP) by students at the appropriate level. Within RiTe I students are required to demonstrate an ability to evaluate and interpret the effects of altering peak kilovoltage (kVp) with a fixed milliamperage second (mAs) on perceptual image quality and DAP using an anthromorphic phantom. In addition to this students are also required to present, evaluate and interpret the data they have collected as part of a formative assessment.

Students are provided with a week-long set of structured activities and work in small collaborative learning groups. They are provided with learning materials, tutorial support and supervision suitable to their academic level. RiTe I is further supported by a summative written assessment task (experiment report) in order to demonstrate proficiency and learning of these learning outcomes at the required level. Formative assessment for RiTe I involves a two hour plenary session where students give a group presentation of their research to members of the academic staff and PhD students as well as their peers. Published evaluative research of RiTe I has demonstrated that these learning outcomes are understood by students and help to enhance their learning and research skill development.[3,4] The learning outcomes are constructively aligned and assessed with the FHEQ level descriptors for higher education qualifications at level 4[9] (Table 3).

Learning outcomes for RiTe II (level 5)

Within RiTe II, students further explore the effects of altering X-ray exposure factors on image quality and radiation dose along with assessing lesion visibility using an anthropomorphic chest phantom (Kyotokagaku N1 "LUNGMAN"). Students calculate the effective dose (E) from DAP measurements using a Monte Carlo (MC) mathematical model. The visual analysis of image quality and

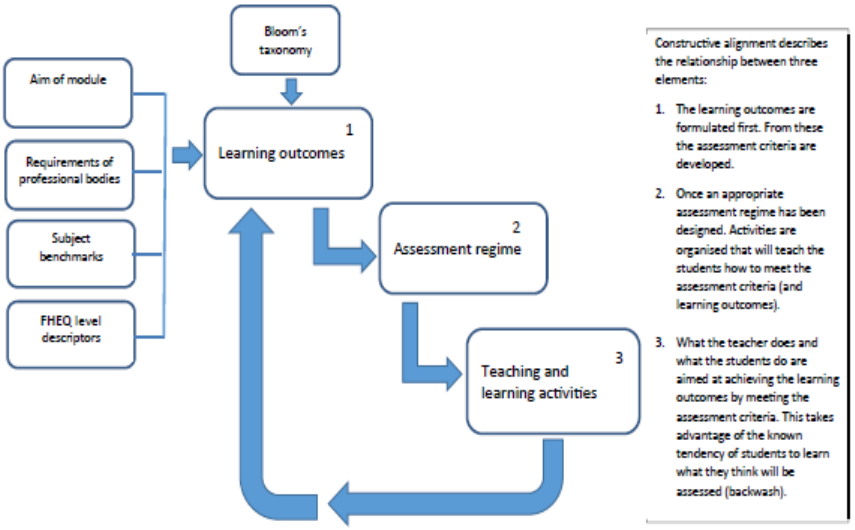

Figure 1. An overview of constructive alignment and factors (1–3) that may influence module design (Adapted from Refs. 18,19).

Table 3
Constructively aligned level 4 descriptors with learning outcomes for RiTe I, the stage of cognitive domain for each learning outcome and assessment tasks. Learning outcome verbs (learning activity) highlighted in bold, its object (content and context) highlighted in italics.

FHEQ level 4 descriptors	Learning outcomes for RiTe I (using Bloom's taxonomy in the cognitive domain)	Stage of Bloom's taxonomy for each in the cognitive domain	Assessment tasks
Knowledge of the underlying concepts and principles associated with their area(s) of study, and an ability to evaluate and interpret these within the context of that area of study	**Demonstrate** *the effects of changing kVp and focal spot size with a fixed mAs on dose area product (DAP) and image quality by undertaking a guided research* **experiment** *design.*	3. Applying; 4. Analysing	Formative discussions via student presentations
An ability to present, evaluate and interpret qualitative and quantitative data, in order to develop lines of argument and make sound judgements in accordance with basic theories and concepts of their subject(s) of study	**Collect** *data for analysis by undertaking a research* **experiment**. **State and explain** *the experimental design process and data analysis by the guided review of related literature and collaborative group work.*	5. Evaluating; 3. Applying 1. Knowledge; 2. Understanding	Experiment report writing workshop
Use their knowledge of the subject and its techniques in a routine manner to evaluate and formulate a range of arguments and solutions to problems and issues of a routine nature	**Discuss and describe** *what is meant by image quality and the key concepts of radiographic image quality.*	2. Understanding; 1. Knowledge	Summative written assessment (experimental report)
Communicate the results of their study and other work accurately and reliably, and within structured and coherent arguments;	**Discuss and describe** *what affects radiographic image quality and DAP.* **Summarise** *the data collected, analyse and present this with regards to the effects of radiographic image quality and DAP when changing kVp (with a fixed mAs) and focal spot size.*	2. Understanding; 1. Knowledge 5. Evaluating	

lesion visibility is assessed using a two-alternative forced choice (2AFC) methodology which measures human observer visual assessment.[21] However, it must be acknowledged that when we set out the learning outcomes for RiTe II the level of task complexity (e.g. calculating E) was considered for level 5 FHEQ level descriptors, but not at the cognitive level. This was because we considered it to be a curriculum enrichment activity. As a consequence some of the learning outcomes used for RiTe II were the same as those used for RiTe I e.g. '*Collect data for analysis by undertaking the research experiment*' with some minor changes to others.

As with RiTe I, RiTe II is delivered over one week with students working in small collaborative learning groups with learning materials and tutorial support suitable to their academic level. There is also more emphasis on independent learning and problem solving. Formative assessment (as with RiTe I) is a two hour plenary session. Students also present a short individual self-reflective report of their experiences and new learning which can be added to their personal development portfolio. However, unlike RiTe I there is no summative assessment.

Method

An online questionnaire was developed to evaluate the student learning experience of a level 5 RiT activity (RiTe II). The questionnaire design was informed by a previous online questionnaire used to collect data from a level 4 RiT activity (RiTe I), although some questions were amended or added to elicit responses based upon knowledge transition from level 4 to level 5.[3] The questionnaire was piloted with five students not in the cohort being evaluated to ensure that participants would interpret questions in the same way. No adjustments were made prior to administration. Some questions were negatively worded in order to reduce acquiescence bias. The questionnaire was delivered online using the Bristol Online Surveys (BOS) website (https://www.onlinesurveys.ac.uk/). It contained 20 closed questions with a free text option to allow students to expand upon their responses. The closed questions were divided into 3 constructs – *Student Experience of the level 5 RiT activity, Teaching and Learning within the level 5 RiT activity* and *Research Skill Development and the level 5 RiT activity*. A five point Likert rating scale was used, ranging from strongly disagree to strongly agree.

The whole level 5 student cohort (total of 46 students) was asked to complete the online questionnaire. This was made available for 8 weeks before being closed. All students shared a common characteristic, in that they all had previously experienced a RiT activity at level 4 (RiTe I). All students were asked to complete the questionnaire following their participation with RiTe II. Ethical approval (HSCR12/12) was granted by the University. All students were provided with a participant information sheet and hyperlink to undertake the questionnaire. The information sheet included details concerning the purpose of the research, what would happen should they take part and who to contact for further information. All participants were assured of anonymity and confidentiality, with each participant having a unique identifier (e.g. participant 1). A reminder was sent out on two separate occasions (at 4 weeks and 6 weeks) in order to increase participation.

Results and discussion

Thirty one out of a cohort of 46 year 2 students completed the questionnaire (67% response rate). Analysis of the questionnaire supported the integration of RiTe II within the curriculum in terms of learning and research skill development. Responses were retrospectively mapped against FHEQ level descriptors for level 5 using constructive alignment. The learning outcomes and how well these related to the student experience at this level was also reflected upon and whether there was a need to change or add learning outcomes to this activity. A summary of the questionnaire data and how the learning outcomes align with expected level 5 descriptors is discussed below.

Twenty nine students (94%) agreed that they could see the relevance of RiTe II within the curriculum and 30 students (97%) agreed that they understood how RiTe II linked with RiTe I. Twenty nine students (94%) agreed that they felt the experience had helped them to further understand the influence of exposure factor selection on image quality and patient radiation dose and how this might be applied in clinical practice. These results align with level 5

FHEQ level descriptors which state that students should demonstrate '*knowledge … of the well-established principles of their area of study*' and demonstrate the '*ability to apply underlying concepts and principles outside the context in which they were first studied*'.[9]

Twenty seven students (87%) agreed that they found the research within RiTe II to be stimulating and interesting, with 30 students (97%) finding the content to be relevant to their learning. Twenty nine students (94%) agreed that they had gained an increased awareness of the methodological issues associated with the research. Only 2 students (7%) agreed that it had not developed their research skills. 27 students (87%) agreed that it helped to develop their critical questioning skills. This is important as it confirms that the learning outcomes for this activity aligned with the FHEQ level 5 descriptors concerned with the '*knowledge of the main methods of enquiry in the subject*' and demonstrating an '*ability to evaluate critically the appropriateness of different approaches to solving problems*'; '*undertake critical analysis of information*' and '*an understanding of the limits of their knowledge*'.[9]

FHEQ level 5 descriptors also state that students should be able to 'effectively communicate information, arguments and analysis in a variety of forms, deploy key techniques of the discipline effectively' and 'develop existing skills'.[9] Twenty six students (84%) agreed that working in small collaborative learning groups was a positive aspect of RiTe II, with 27 students (87%) also agreeing that they enjoyed managing their own learning (self-directed learning) and undertaking research. Twenty nine students (94%) also agreed that it had been beneficial in supporting and stimulating ideas for their final year level 6 (year 3) dissertation project. Finally, 26 students (84%) agreed that being able to use research skills was seen as an important part of their career development.

Free-text comments by students included:

Participant 1: *'I feel that I have further improved team working skills'*

Participant 2: *'Research skills have improved… Presentation skills have also improved, because I was able to present with confidence'*

Participant 3: *'I feel I have gained an increased understanding when applying exposure factors to obtain a radiographic image.... This knowledge can be carried forward and applied under supervision on clinical placement as a student and as a qualified healthcare professional in the work place'.*

However 1 student did comment that:

Participant 4: *'I don't think I got as much benefit from it as I could have if part of my role had been to do the Excel stuff or learn the [dose calculation and image appraisal] software. Instead I spent most of my time researching and putting the PowerPoint together'*

What have we learnt from this evaluation?

Developing as a critically reflective academic contributes to excellence in teaching, and improved educational outcomes.

Table 4
Level 5 descriptors with current and proposed revised learning outcomes for RiTe II, the stage of cognitive domain for each learning outcome has been retrospectively mapped using Bloom's taxonomy. Learning outcome verbs (learning activity) highlighted in bold, its object (content and context) highlighted in italics.

FHEQ level 5 descriptors	Current learning outcomes for RiTe II (using Bloom's taxonomy in the cognitive domain)	Stage of Bloom's taxonomy for each in the cognitive domain (retrospectively mapped)	Revised learning outcomes for RiTe II (using Bloom's taxonomy in the cognitive domain)	Stage of Bloom's taxonomy for each learning outcome in the cognitive domain
Knowledge and critical understanding of the well-established principles of their area(s) of study, and of the way in which those principles have developed	**Propose** *a research experiment designed to collect and analyse data for this research by the guided review of related literature and collaborative group work.*	5. Evaluating	**Propose and justify** *a research experiment designed to collect and analyse data for this research by the guided review of related literature and collaborative group work*	5. Evaluating; 6. Creating
Ability to apply underlying concepts and principles outside the context in which they were first studied, including, where appropriate, the application of those principles in an employment context	**State and explain** *the experimental design process and data analysis by the guided review of related literature and collaborative group work.*	1. Remembering; 2. Understanding	**Describe** *the research experiment methodology* **Conduct** *the proposed research* **experiment**	1. Knowledge 5. Evaluating; 3. Applying
Knowledge of the main methods of enquiry in the subject(s) relevant to the named award, and ability to evaluate critically the appropriateness of different approaches to solving problems in the field of study	**Collect** *data for analysis by undertaking the research* **experiment**.	5. Evaluating; 4. Analysing	**Interpret** *the data collected analyse and present this with regards to the effects of radiographic image quality and effective dose*	6. Creating
Use a range of established techniques to initiate and undertake critical analysis of information, and to propose solutions to problems arising from that analysis	**Summarise and interpret** *the data collected and present this with regards to the effects of radiographic image quality, calcification/tumour visibility and effective dose.*	5. Evaluating; 6. Creating	**Explain** and **appraise** *the effects of changing SID and key radiographic exposure factors and how these impact upon image quality and effective dose*	2. Understanding 4. Analysing
Effectively communicate information, arguments and analysis in a variety of forms to specialist and non-specialist audiences and deploy key techniques of the discipline effectively	**Discuss and describe** *the key concepts of chest/pelvis image quality and tumour/calcification visibility.* **Discuss and describe** *the effects of changing SID and key radiographic exposure factors (kVp and mAs/density control adjustment), and how these impact upon image quality and effective dose.*	2. Understanding; 1. Knowledge 2. Understanding; 1. Knowledge	**Explain** and **justify** *choice of statistical test within the context of the research undertaken* **Evaluate** *the key areas contributing to current and future practice or experience*	2. Understanding 5. Evaluating 6. Creating

Analysing one's own learning and teaching practices (and the understanding of these) also contributes to effective teaching practice within the curriculum.[22] By retrospectively mapping the learning outcomes, undertaking a student evaluation and reflecting upon this, it was found that there was constructive alignment between the learning outcomes and FHEQ level 5 descriptors for this RiT activity. However, upon further reflection it was felt that we could further revise and incorporate more of the higher level cognitive processes within the learning outcomes for RiTe II using Bloom's taxonomy (Evaluating and Creating). We also felt that there was an absence of a learning outcome for students to discuss how their learning and experience might contribute towards their own current and future practice following RiTe II, despite student agreement in the questionnaire that they felt able to apply this knowledge in the clinical environment. Indeed student feedback tended to focus on how this knowledge might be used to help with their final year research dissertation. Some of the learning outcomes will now be amended to reflect this and an additional learning outcome will be included that requires students to consider how RiTe II might contribute towards their practice (Table 4).

Another point for consideration is the generation of a summative assessment process that constructively aligns with the learning outcomes for this activity in order to ensure that students demonstrate these. Both RiT activities are under review as part of a Periodic Programme Review and Re-Approval (PPRR) for a new undergraduate programme in 2017 and this provides an opportunity to reassess this aspect of both activities. Within both RiT activities it could also be argued that students are demonstrating learning outcomes in the psychomotor domain.[9] Again there may be a need to consider the learning outcomes for both and how these might better align within this domain.

Currently there is no RiT activity for level 6 (year 3), although students do undertake a summative dissertation as part of a research methods module. This is individually focussed and the learning and assessment process may present a mismatch with best practice in research and clinical practice – unlike both RiTe I and II there is no collaborative learning or team working on their research dissertation. However, consideration needs to be given that in order to achieve constructive alignment there is a need for a variety of assessment methods as a narrow range of assessments will only assess a narrow range of skills.[22] Nonetheless, Okubo et al.,[23] state that team based learning supports the acquisition of clinical reasoning skills by students which is difficult to achieve in lectures or a tutor-centred learning approach. There are also a number of benefits with using team based research strategies where diverse perspectives based on prior experiences or methodological skills can help to solve a problem and enable the sharing of expertise or knowledge. Using team based research also avoids the premature convergence on conclusions, by providing critics who may identify potential problems and additional opportunities during a project.[24,25] The level 6 descriptors (or at any level) do not include team-based research. However, a UK Diagnostic Radiography benchmark states that one of the skill sets should be "*effective skills in communicating information, advice, instruction and professional opinion to colleagues, patients, clients, their relatives and carers; and, when necessary, to groups of colleagues or clients.*"[26] Therefore, this is an area worthy of further exploration within the concept of further integrating a RiT activity within the curriculum at level 6. The format and resourcing of this would need to be considered alongside the learning outcomes and assessment to ensure that these were constructively aligned against the appropriate level 6 descriptors and encompassed higher level cognitive skills and any relevant psychomotor and affective domain skills. Based on current experience, this is something that can be achieved by the careful deliberation over what students need to be able to demonstrate (learning outcomes) and how these align against level 6 descriptors and assessment criteria (Fig. 2).

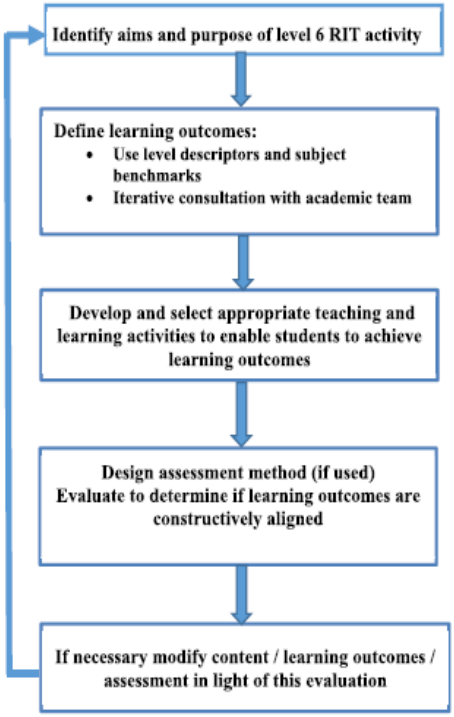

Figure 2. Flowchart summarising proposed the steps involved in the development of constrictively aligned learning outcomes, teaching activities and assessment for a level 6 (year 3) RiT activity (Adapted from Ref. 10).

Conclusion

Level 5 student evaluation determined that the learning outcomes for RiTe II constructively aligned with what the students felt that they had learnt or were able to demonstrate following their experiences with this activity. It also identified areas that require further improvement (for example some of the learning outcomes could be re-written with a focus on higher-order thinking and application skills). If learning outcomes are written within a very narrow framework, this can limit learning and may result in a lack of intellectual challenge for some students.[9] By reflecting upon and using a constructive alignment framework to assess this RiT activity, we have been able to confirm that although not explicitly specified at the beginning of the task, relevant learning outcomes were ultimately realised and linked well with the appropriate level descriptors. However, it also highlighted to us that further refinements were needed to ensure students undertook a more critical review of how the knowledge and skills gained from this activity could be used in their own practice. Another potential limitation is a lack of summative assessment to determine whether there is a true alignment between the learning outcomes, learning activities and demonstration of these by students and this is an area for further development.

Conflict of interest statement

None.

References

1. University Alliance and Higher Education Academy. *What does research-informed teaching look like?*. York: The Higher Education Academy; 2016.
2. Higgins R, Hogg P, Robinson L. Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: a pilot study. *J Vocat Educ Train* 2013a;**65**(3):351–68.
3. Higgins R, Hogg P, Robinson L. Integrating research informed within and undergraduate diagnostic radiography curriculum: the level 4 (year 1) student holistic experience. *Radiography* 2013b;**19**:62–6.
4. Higgins R, Robinson L, Hogg P. Integrating research informed within and undergraduate diagnostic radiography curriculum: results from a level 4 (year 1) student cohort. *Radiography* 2014;**20**:100–6.
5. The Quality Assurance Agency for Higher Education (QAA). *UK quality code for higher education part A: setting and maintaining academic standards. The frameworks for higher education qualifications of UK degree-awarding bodies. October 2014*. Southgate House, Gloucester: The Quality Assurance Agency for Higher Education; 2014.
6. Spronken-Smitha R, Walkera R, Batchelorb J, O'steenc B, Angelod T. Enablers and constraints to the use of inquiry-based learning in undergraduate education. *Teach High Educ* 2011;**16**(1):15–28.
7. Turjanksky T. *Learning outcomes and level descriptors*. Available from: https://www.edgehill.ac.uk/clt/files/2012/02/LOs-Level-Descriptions-23Oct13.pdf; 2013 [Accessed 13 April 2016].
8. Moon J. *Linking levels, learning outcomes and assessment criteria*. Bologna Seminar: Exeter University; 2004.
9. The Quality Assurance Agency for Higher Education (QAA). *UK quality code for higher education. February 2015*. Southgate House, Gloucester: The Quality Assurance Agency for Higher Education; 2015.
10. Kennedy D, Hyland A, Ryan N. *Writing and using learning outcomes: a practical guide*. Cork: University College Cork; 2006.
11. McMahon T. Teaching for more effective learning: seven maxims for practice. *Radiography* 2005;**12**(12):34–44.
12. Mager RF. *Preparing instructional objectives*. Palo Alto, CA: Fearon; 1962.
13. Melton R. *Objectives, competences and learning outcomes: developing instructional materials in open and distance learning*. London: Kogan; 1997.
14. D'Andrea V. Organising, teaching and learning: outcomes-based planning. In: Fry H, Ketteridge S, Marshall S, editors. *A handbook for teaching education*. 2nd ed. London: Kogan; 2003.
15. Bloom BS, Engelhart MD, Furst EJ, Hill WH, Krathwohl DR. *Taxonomy of educational objectives: cognitive domain*. New York: McKay; 1956.
16. Anderson LW, Krathwohl D, editors. *A taxonomy for learning, teaching and assessing: a revision of Bloom's taxonomy of educational objectives*. New York: Longman; 2001.
18. Biggs J. *Aligning teaching and assessment to curriculum objectives*. Imaginative Curriculum Project, LTSN Generic Centre. 2003.
19. Centre for Excellence in Learning and Teaching (CELT). *Writing and assessing unit level learning outcomes: constructive alignment explained*. 2016. Available from: http://www.celt.mmu.ac.uk/curriculum/learning_outcomes/constructive_alignment.php [Accessed 16 February 2016].
20. Tepper J. *Design a module using the principles of constructive alignment*. Nottingham Trent University; 2008 [online] Available at: www.ntu.ac.uk/casq [Accessed 21 April 2016].
21. Thompson JD, Manning DJ, Hogg P. Analysing data from observer studies in medical imaging research: an introductory guide to free-response techniques. *Radiography* 2014;**20**(4):295–9.
22. Larrivee B. Transforming teaching practice: becoming the critically reflective teacher. *Reflective Pract* 2000;**1**(3):293–307.
23. Rust C. *Developing a variety of assessment methods*. PowerPoint Presentation. Oxford Centre for Staff and Learning Development. Oxford: Oxford Brookes University; 2004.
24. Okubo Y, Ishiguro N, Suganuma T, Nishikawa T, Takubo T, Kojimahara N, et al. Team-based learning, a learning strategy for clinical reasoning, in students with problem-based learning tutorial experiences. *J Exp Sci* 2012;**227**:23–9.
25. Garland DR, O'Connor MK, Wolfer TA, Netting FE. Team based research: notes from the field. *Qual Soc Work* 2006;**5**(1):94–107.
26. The Quality Assurance Agency for Higher Education (QAA). *Benchmark statements: health programmes: radiography*. Southgate House, Gloucester: The Quality Assurance Agency for Higher Education; 2001.

PAPER 6:

RESEARCH INFORMED EXPERIENCE IN DIAGNOSTIC RADIOGRAPHY: THE PERSPECTIVES OF ACADEMIC TUTORS AND CLINCIAL PLACEMENT EDUCATORS

Research informed teaching experience in diagnostic radiography : the perspectives of academic tutors and clinical placement educators

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Educational Perspective

Research Informed Teaching Experience in Diagnostic Radiography: The Perspectives of Academic Tutors and Clinical Placement Educators

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ABSTRACT

Introduction: This small scale, qualitative research study investigated the perceptions by both academic tutors and clinical placement educators of integrating the research-informed teaching experience (RiTe) within an undergraduate radiography curriculum to support the learning and practice of image quality and dose optimization.

Method: A purposeful sampling approach was used to recruit participants and two asynchronous online focus groups (OFG) were used for data collection. An inductive thematic approach was taken to analyse both sets of OFG data.

Results and discussion: Five academic tutors and four clinical placement educators participated in the research. Three overarching themes common to both sets of OFG data were identified. Findings confirmed that both OFGs felt that the RiTe supported student learning of image quality and dose optimization as well as the development of research skills. However, the clinical placement educators did identify that students may find it difficult to transfer and apply this knowledge into practice (theory-practice gap).

Conclusion: Results from both OFGs support RiTe with regard to the teaching and practice of image quality and dose optimization. However, greater involvement by clinical placement educators may help to overcome issues with the translation of RiTe by students into the clinical environment (theory-practice gap) and support its continued development within the curriculum. It was also identified that RiTe could be developed for qualified staff for continued professional development.

RÉSUMÉ

Introduction : Dans cette étude de recherche qualitative à petite échelle, les auteurs se penchent sur les perceptions des enseignants et des éducateurs en stages cliniques sur l'intégration de l'expérience d'enseignement fondée sur la recherche (EEFR) dans le contexte d'un programme d'enseignement de premier cycle en radiographie pour appuyer l'apprentissage et la pratique de la qualité de l'image et de l'optimisation de la dose.

Méthodologie : Une approche d'échantillonnage non aléatoire a été utilisée pour recruter les participants et deux groupes de discussion en ligne asynchrone ont été utilisés pour la collecte de données. Une approche thématique inductive a été utilisée pour analyser les deux ensembles de données provenant des groupes de discussion.

Résultats et discussion : Cinq enseignants et quatre éducateurs en stages cliniques ont participé à la recherche. Trois thèmes principaux sont ressortis dans les ensembles de données des deux groupes de discussion. Les résultats confirment que les deux groupes de discussion considèrent que l'expérience d'enseignement fondée sur la recherche (EEFR) appuie l'apprentissage par les étudiants de la qualité de l'image et de l'optimisation de la dose ainsi que le développement des compétences de recherche. Les éducateurs en stages cliniques ont cependant indiqué que les étudiants pouvaient avoir de la difficulté à transférer et appliquer ces connaissances en pratique (fossé entre la théorie et la pratique).

Conclusion : Les résultats des deux groupes de discussion soutiennent l'expérience d'enseignement fondée sur la recherche (EEFR) en ce qui concerne l'enseignement et la pratique de la qualité de l'image et de l'optimisation de la dose et soutiennent son développement continu dans le curriculum. Cependant, une plus grande participation par les éducateurs en stages cliniques pourrait contribuer à corriger les problèmes de transfert de l'EEFR dans l'environnement clinique par les étudiants (fossé entre la théorie et la pratique) et soutenir son développement continu dans le curriculum. Il a également été indiqué que l'EEFR pourrait être développé pour le personnel qualifié dans le cadre du perfectionnement professionnel continu (PPC).

Keywords: Pedagogy; radiography; theory-practice gap; continual professional development; clinical placement; skill acquisition

Conflicts of Interest: None.

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Introduction and Background

The research-informed teaching experience (RiTe) was developed in 2009 and is now fully integrated within our BSc (Hons) Diagnostic Radiography Programme and summative assessment scheme. RiTe uses a combination of research, simulation, and inquiry-led learning to support the application of theoretical knowledge, research skill development, and clinical practice by our year 1 and year 2 students. The active involvement of students within subject-based research has been shown to not only enhance knowledge but also to develop student research and communication skills (particularly when they are involved with some or all of the research stages) [1, 2]. Specifically, RiTe encourages our students to undertake an inquiry-led approach to learning within small groups to research the effects of x-ray exposure factor manipulation on image quality and dose optimization [3]. Evaluative research of the student experience of RiTe has supported its introduction as a teaching strategy with regard to the knowledge acquisition and practical application of image quality and dose optimization, as well as the development of research skills [4–6].

Clinical hospital placements form an essential part of the undergraduate student radiographers' education and provides opportunities to work in real life environments where theory can be integrated into practice [7]. However, a phenomenon known as the theory-practice gap has been identified across multiple health care disciplines, whereby students struggle to apply taught theory with the reality of practice. This gap may also affect professional competence and contribute to difficulties in progressing from student to novice professional [8, 9]. Clinical placement educators (CPEs) play a vital role in supporting students so that they gain the appropriate experience and skills to bridge this gap and help to support the continued development of the undergraduate curriculum by recognizing the value of linking theory with clinical practice [9].

Although the student experience of RiTe has previously been reported [4–6], no research has been undertaken to explore the academic or CPE point of view. The purpose of this small-scale qualitative study was therefore to explore these perspectives with regard to the integration of RiTe within the curriculum and in supporting student learning and practice of image quality and dose optimization. This would also determine opportunities for the further development of RiTe.

Method

Ethical Approval

Ethical approval was granted before recruiting participants and good ethical practice was followed, which included informed consent via an information sheet and the use of closed online focus groups (OFG). Confidentiality was emphasized to all OFG participants by the researcher and participants were asked not to share information outside each OFG. Given the professional background of the participants, it was expected that this would be respected.

Data Collection

A qualitative study using purposeful sampling was used to recruit participants for two asynchronous OFGs, one for academic tutors (ATs) and one for CPE. Purposeful sampling is a recognized technique in qualitative research as it aims to target key informants who will have a specific and unique perspective on a phenomenon [10]. For the AT OFG, a wide range of opinions from a number of different perspectives (eg, strategic vision, resource management, and pedagogical responsibilities) were sought and the following were asked to participate as they each provided a unique perspective or experience of RiTe—a Physicist who teaches on the Undergraduate Programme, a member of the academic staff who teaches imaging technique, the Research Dean, Undergraduate and Postgraduate Programme Leaders, Academic Head of Department, Clinical Learning Manager, and an AT with an awareness of, but no involvement with RiTe. The University currently has 12 CPEs who act as the primary liaison between the University and hospital clinical placement sites and all were invited to participate.

The use of asynchronous OFGs provided a convenient way for participants to engage with the research since there were no constraints with regard to arranging venues and times. Responses in the OFGs were transferred directly into an electronic document so they were accessible for analysis without the need for transcription or editing, thereby enhancing the accuracy of collected data and eliminating transcriber bias [11]. This approach also encouraged the exchange of experiences and allowed participants to comment on each other's interpretations of RiTe [12, 13].

Each OFG was conducted within the Blackboard Virtual Learning Environment via an online Wiki and access was restricted to participants for each OFG. Seven semi-structured questions were discussed by both OFGs (Table 1) with the first author/researcher acted as moderator to ensure participants posted responses to the questions posed [14]. Both OFGs ran for 6 weeks with the moderator asking participants to visit their respective OFG at least once a week. Participants were also invited to add comments which were used by the moderator to generate further questions for exploration.

Data Analysis

An inductive thematic approach was taken to analyse both sets of OFG data. This approach was selected to allow themes to emerge from the data and to provide a more open-ended and exploratory approach to the research. Thematic analysis also provided a flexible research tool when searching for and identifying common themes that extended across both OFGs. Codes were assigned to overarching themes by following the six-phase process outlined by Braun and Clarke [15] (Table 2). Similarly, the

Table 1
Semi-structured Questions Used in Both OFGs

Q1. To begin the discussion let us consider your understanding or perception of RiTe with regards to student teaching and learning. What are these?
Q2. What strengths or opportunities did you feel RiTe offers our students?
Q3. What weakness (if any) are there with RiTe? What changes you make?
Q4. Would you agree that RiTe has a role in developing theoretical and clinical knowledge of our students? If yes then what is this role?
Q5. Do you think we need to provide guidance material or information about RiTe to those clinical and academic tutors not involved with RiTe? If so what should be included?
Q6. Do you have any recommendations regarding the further development of RiTe? For example do think there are opportunities to involve qualified staff to participate with this?
Q7. The learning outcomes for RiTe are currently linking theory with practice (image quality, patient radiation dose optimisation and exposure factor manipulation) sharing knowledge with others and the development of research skills. Do you agree with these? If not what do you think they should be?

15-point checklist developed by Braun and Clarke [15] was used for coding and analysing both sets of OFG data (Table 3). This ensured the credibility and dependability of the research by the adoption of a well-established analytical approach [16].

Coding was "data-driven" in that themes were derived from the data rather than coding for specific research questions. Data were coded manually by making notes adjacent to the analysed data (Table 4). Each code was then matched up with the relevant data extract that demonstrated this code to aid with the overall conceptualization of the data patterns and the relationships between them [15].

Once all the data for both OFGs had been coded, these were arranged into potential themes with the relevant coded data collated within each identified theme [15]. Consideration was also given as to whether the themes contained any sub-themes to give them a hierarchy of meaning [15]. Final refinements were made by determining what aspect of the data each theme captured and whether the themes could be triangulated between both OFGs.

Results and Discussion

Five ATs and four CPEs participated with the research (Table 5).

Three overarching themes common to both sets of OFG data were identified. These were RiTe and student learning, RiTe and the value of research, and translation of RiTe into practice, with each also having two or more sub-themes (Figure 1).

RiTe and Student Learning

Group Working and Learning

Both OFGs identified that RiTe helped students to learn and work together:

> **AT 5:** "It builds on the PBL [Problem Based Learning] ethos of independent learning and problem solving … but emphasises team working in researching shared goals."

> **CPE 4:** "It promotes the group working ethos that they have previously experienced through PBL, however they are encouraged to become more of a team with a common goal."

Previous research exploring the student experience of RiTe also reported this finding with regard to collaborative learning by students via team working [5, 6]. However, this approach was also seen to have some disadvantages.

> **AT 1:** "Some students can sit back and disengage from the group activities and this leads to tension with the research active students in the same group"

One CPE asked:

> **CPE 1:** "Do all students participate? Maybe not best suited to all learning styles?"

Students working in groups may experience interpersonal conflicts or there can be a lack of balance in the work accomplished by each student, allowing some students to disengage from the process [17]. In year 1, RiTe forms part of a summative assessment with an experiment report, but currently there is no such assessment in year 2. Anecdotal feedback has suggested that the absence of a summative assessment can led to a lack of engagement by some students during group work. One method to address this problem would be the introduction of peer assessment, whereby students rate one another with regard to group participation and team contribution [18]. This may also provide an opportunity for students to develop skills in encouraging engagement from those not actively participating with group work.

Table 2
Six Phases of Thematic Analysis [15]

Phase	Description of Process
1. Familiarisation with data	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2. Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3. Searching for themes	Collating codes into potential themes, gathering all data relevant to each code.
4. Reviewing themes	Checking themes work in relation to coded extracts (Level 1) and the entire data set (Level 2), generating a thematic "map" of the analysis.
5. Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells; generating clear definitions and names for each theme.
6. Producing the report	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of the selected extracts, relating back of the analysis to the research question and literature.

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Table 3
Fifteen-Point Checklist of Criteria [15]

Process	No.	Criteria
Transcription	1	The data have been transcribed to an appropriate level of detail, and the transcripts have been checked against the tapes for "accuracy"
Coding	2	Each data item has been given equal attention in the coding process.
	3	Themes have not been generated from a few vivid examples (an anecdotal approach), but instead the coding process has been thorough, inclusive, and comprehensive.
	4	All relevant extracts for all each theme have been collated.
	5	Themes have been checked against each other and back to the original data set.
	6	Themes are internally coherent, consistent, and distinctive.
Analysis	7	Data have been analysed—interpreted, made sense of—rather than just paraphrased or described.
	8	Analysis and data match each other—the extracts illustrate the analytic claims.
	9	Analysis tells a convincing and well-organised story about the data and topic.
	10	A good balance between analytic narrative and illustrative extracts is provided.
Overall	11	Enough time has been allocated to complete all phases of the analysis adequately, without rushing a phase or giving it a once-over-lightly.
Written report	12	The assumptions about, and specific approach to, thematic analysis are clearly explicated.
	13	There is a good fit between what you claim you do, and what you show you have done—ie, described method and reported analysis are consistent.
	14	The language and concepts used in the report are consistent with the epistemological position of the analysis.
	15	The researcher is positioned as active in the research process; themes do not just "emerge"

Resource Management

Both OFGs commented that RiTe as a learning activity enabled students to see the effects of changing exposure factors on image quality and dose optimization for themselves (something they would be unable to do in clinical practice).

Table 4
Example of Data Extract With Code Applied for Academic Tutor OFG

Data Extract	Initial Codes
Yes, if the research problem is selected carefully (1) to match their required learning at the point in their curriculum (2). Sometimes students may need a little help to see the links with clinical practice – involvement of placement in this process would really help here (3). (*Academic Tutor 5 [AT 5] 5:25:15/9/2015*)	1. Research 2 Teaching and learning 3. Practice/placement

Table 5
Participants for Academic Tutor (AT) and Clinical Placement Educator (CPE) OFGs

Role	Level of Involvement With RiTe
Senior Lecturer (AT 1)	None
Senior Lecturer (AT 2)	Involved with development of RiTe and integration into undergraduate curriculum
Research Dean (AT 3)	Involved with development and teaching of RiTe
Lecturer (AT 4)	None
Academic Head of Department (AT 5)	None
Clinical Placement Educator (CPE 1)	None
Clinical Placement Educator (CPE 2)	None
Clinical Placement Educator (CPE 3)	None
Clinical Placement Educator and Lecturer (CPE 4)	Involved with teaching of RiTe

It also allowed them to be creative with their learning. However, the AT OFG did acknowledge that a consequence of this approach was an additional demand on resources.

> **AT 4:** "It takes a lot of planning in terms of student allocations and staff resources and would not be as cost effective as a traditional teaching programme."

> **AT 3:** "It is physically resource intensive."

Some of the CPEs raised concerns about qualified radiographers discussing with students what they learnt during RiTe once back in clinical placement.

> **CPE 3:** "I don't think staff in the clinical [hospital] department realise that RiTe exists. I am not sure even if they knew that it did, that they would get into a discussion with students."

> **CPE 2:** "Like CPE 3, I am also not sure how much clinical staff [radiographers] would engage with students about RiTe."

Guidance documentation has been produced and circulated to each CPE and clinical placement to try and raise awareness of the purpose of RiTe and to encourage discussions between students and radiographers.

RiTe and Radiography Research

Research Skill Development

Both OFGs identified RiTe as a way for students to develop their research skills at an early stage in their careers.

> **AT 5:** "Students are exposed to research far earlier in their programme than was the case with our previous [BSc (Hons)] curriculum, and it is "hands on" rather than "dry" lectures on research methodology. They will appreciate the latter more once they have had this research experience."

> **CPE 4:** "RiTe enables them to engage with the [research] process by letting them try it out for themselves as opposed to reading the research of others."

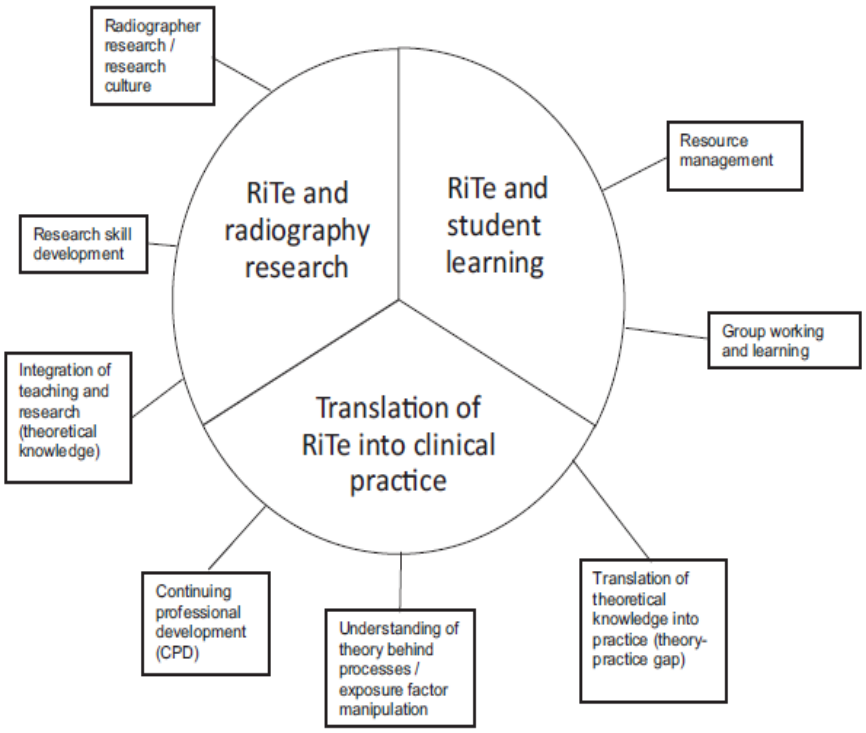

Figure 1. Final thematic map, showing three main themes.

Radiographer Research/Research Culture

The development of a research culture within radiography and using research evidence in clinical practice was also commented on by both OFGs.

> **AT 1:** "… It makes them question clinical practice and to look at evidence based research—really important attributes in undergraduates."

> **CPE 4:** "… promotes the culture of research within the radiography profession."

The development of a research culture was seen as being important with regard to developing an evidence base for radiographic practice as traditionally radiography has been seen as a consumer of research, rather than a producer of research [19]. The Council for Allied Health Professions Research [20] has issued a position statement that aims to develop the research awareness of all allied health professions (AHP) preregistration students and prepare them for embedding research within their practice. The Society and College of Radiographers [21] has also updated its research strategy for 2016–2021, which now targets all levels of the profession from preregistration to expert practitioner to embed research at all levels of radiography practice and education.

Integration of Teaching and Research (Theoretical Knowledge)

Although the majority of ATs saw RiTe as a positive way of integrating research with teaching to build on the theoretical knowledge and application in practice of image quality and dose optimization, a number of the CPEs were not convinced that students were actually applying this knowledge in clinical practice.

> **CPE 2:** "After attending one of the RiTe presentations, I was surprised by how much the student's evaluation of what they had learned identified 'soft' skills, eg, interpersonal skills, team working, public speaking or problem solving … Most of these are useful clinical skills … but not necessarily the skills that we would have expected."

Research is a complex skill and requires a number of diverse sub-skills such as critical thinking or developing a research method. Learning how to share expertise and/or knowledge through the effective participation in a research team is just as important as undertaking the research itself and this may have been not fully appreciated by some CPEs [22].

Translation of RiTe into Clinical Practice

Understanding of Theory Behind Processes/Exposure Factor Manipulation

The AT OFG felt that RiTe helped students to develop an understanding of the manipulation of x-ray exposure factors and the effect these have on image quality and dose optimization.

> **AT 2:** "[RiTe] gives the students the opportunity to experiment with exposure factors so they can see the results for

themselves and therefore a deeper understanding of the theory."

AT 4: "They are able to put their theory into practice … and the knowledge can be transferred to clinical practice."

Translation of Theoretical Knowledge into Practice (Theory-Practice Gap)

However, some CPEs did question whether these skills and knowledge were actually being applied in practice.

CPE 2: "Students say they have gained a better understanding of [x-ray] exposure factor manipulation, but I don't necessarily see the evidence of this in their clinical practice."

CPE 1: "It has a place in developing practical skills, ie, use of [x-ray] exposure factors and methods to measure [radiation] dose … but I am not convinced that in practice students are displaying an enhancement of their theoretical knowledge."

One AT also questioned whether the knowledge and skills learned during RiTe influenced clinical practice and if more involvement by CPEs was needed.

AT 2: "… [Student] presentations [at the end of each RiTe week] suggest it makes them think about clinical knowledge … I'm not sure how long this is sustained. We don't really follow this up on clinical placement to see if has influenced their practice."

However, this lack of translation of acquired knowledge and skills into clinical practice could be because of students feeling unable to apply or discuss these when working with qualified radiographers. This was identified with previous research whereby students agreed that the research undertaken during RiTe would influence their clinical practice, but felt unable to share this knowledge with qualified radiographers [5]. Workplace culture together with diverse unwritten rules, assumptions, and expectations has a strong influence on the use of research evidence within practice [23].

Changing practice is therefore not just about translating knowledge into practice, but also training in leadership skills to give students the confidence to be able to use or share knowledge and skills in the clinical setting [4].

CPE 2: "I think they [students] need more confidence to articulate their findings in clinical practice. However, I acknowledge that this can be difficult because it can sometimes be perceived as questioning the radiographer's judgement."

Currently, the CPEs have little involvement with RiTe as part of the curriculum and findings would suggest that to support the development of RiTe, this is an area that needs to be addressed. Further involvement by CPEs with RiTe will help to ensure that the theoretical and the simulation aspect of RiTe aligns with the student experience of clinical practice as well as fostering the translation of RiTe within the clinical setting to help bridge the theory practice gap [24]. However, one CPE did identify RiTe as having a role in developing knowledge and linking this with practice.

CPE 4: "RiTe provides a unique opportunity not only to develop theoretical understanding, but also allows the student to see the difference that alteration of [x-ray] exposure factors makes to their image. This is not something they could do in clinical practice."

Continuing Professional Development

Both OFGs identified that RiTe could be developed as a Continuing Professional Development (CPD) learning activity for qualified radiographers to develop and enhance their own knowledge and research abilities.

AT 4: "I think giving qualified staff the opportunity to participate [with RiTe] would be an excellent development. There are areas of radiography where staff are trained to perform tasks without having the underlying knowledge and understanding. It would be a great way to introduce and consolidate understanding."

However, the CPE OFG did raise the potential issue of reluctance by departments in releasing staff to attend such an activity.

CPE 2: "I think it would be a good opportunity to be available, but I'm not sure how many departments would be able to release staff for this."

CPE 4: "This is a great opportunity for CPD for staff [qualified radiographers], however departmental limitations with regards to staffing will always have a negative impact."

The understanding of the manipulation of x-ray exposure factors on image quality and dose optimization is an important area for development and professional autonomy. However, a number of articles have identified that there may be an over-reliance on using preset exposure factors resulting in a lack of consideration when optimizing patient x-ray examinations. Factors that contribute most frequently to dose and image quality variation lie in decisions concerning radiographic technique (including the selection of x-ray exposure factors) made by radiographers [25, 26]. Preregistration or CPD activities such as RiTe may be one way to address this issue and to promote a research culture within the profession.

Limitations

Purposeful sampling aims to address representativeness and the inclusion of key informants rather than to eliminate bias. However, it must be recognized that when undertaking qualitative research, the researcher should be reflexive to explain their position and influence on the data analysis [27, 28]. The main author of this research has been involved in the delivery and evaluation of RiTe since inception and brings a specific knowledge base and set of preferences that will have influenced the way the themes were derived. Having a second analyst involved in theming the data would have helped to

confirm the trustworthiness of the themes, but because of resource limitations, this was not undertaken. Nevertheless, the article was authored by a team who agreed the content and all the themes (which captured the participants' comments) provided in Figure 1.

Conclusion

Results from both OFGs agreed that RiTe supports student understanding of the theory behind x-ray exposure factor manipulation and the effects of this on image quality and dose optimization. Both OFGs also agreed that RiTe develops and supports student research skills, which is important in working toward a research culture in line with the aims set out by the CAHPR and Society and College of Radiographers [20, 21]. However, the CPE OFG did feel that students were demonstrating "soft" clinical skills and raised concerns that students were not necessarily applying all the knowledge gained from RiTe in clinical practice (theory-practice gap). This could be due to a lack of student confidence in articulating what they had learnt during RiTe when in clinical practice or full appreciation by CPEs of the objectives of RiTe. The further involvement of CPEs with RiTe could help to support its development within the curriculum and thereby help students to apply RiTe in practice; this is a key action point for the researchers and Programme team.

Although RiTe supports students as researchers and encourages their involvement with research at undergraduate level, as a newly qualified radiographer, it may be difficult to retain interest with research once in the workplace. To encourage a culture of research post qualification, CPD activities such as a revised version of RiTe could help to support this. However, consideration would need to be given to workplace pressures in releasing staff to attend—for example, RiTe could be shortened to a 2-day workshop instead of weeklong activity.

References

[1] Healy, M. (2005). Linking research and teaching to benefit student learning. *J Geogr Higher Education* 29(2), 183–201.

[2] University Alliance and Higher Education Academy (2016). What Does Research-informed Teaching Look Like? York: The Higher Education Academy.

[3] Higgins, R., Hogg, P., & Robinson, L. (2015). Guest editorial: Unlocking student research potential: toward a research culture in radiography undergraduate learning curricular. *J Med Imag Radiat Sci* 46, S6–S9.

[4] Higgins, R., Hogg, P., & Robinson, L. (2013a). Integrating research-informed teaching within an undergraduate level 4 (year 1) diagnostic radiography curriculum: a pilot study. *J Vocational Education Train* 65(3), 351–368.

[5] Higgins, R., Hogg, P., & Robinson, L. (2013b). Towards a research informed teaching experience within a diagnostic radiography curriculum: the level 4 (year 1) student holistic experience. *Radiography* 19, 62–66.

[6] Higgins, R., Robinson, L., & Hogg, P. (2014). Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: results from a level 4 (year 1) student cohort. *Radiography* 20(2), 100–106.

[7] Mifsud, C. P., Castilio, J., & Portelli, J. L. (2015). Radiography students' clinical placement experiences in MRI: a phenomenological study. *Radiography* 21(1), 17–20.

[8] Michau, R., Roberts, S., Williams, B., & Boyle, M. (2009). An investigation of theory-practice gap in undergraduate paramedic education. *BMC Med Education* 9, 23.

[9] Billings, D. M., & Kowalski, K. (2006). Bridging the theory–practice gap with evidence-based practice. *J Continuing Education Nurs* 37(6), 248–249.

[10] Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Adm Policy Ment Health Ment Health Serv Res* 42(5), 533–544.

[11] Tates, K., Zwaanswik, M., & Otten, R., et al. (2009). Online focus groups as a tool to collect data in hard-to-include populations: examples from paediatric oncology. *BMC Med Res Methodol* 9, 15.

[12] Adams, J., & Smith, T. (2003). Qualitative methods in radiography research: a proposed framework. *Radiography* 9, 193–199.

[13] Edmunds, H. (1999). The Focus Group Research Handbook. Lincolnwood, IL: NTC Business Books/Contemporary Publishing.

[14] Williams, S., Clausen, M. G., Robertson, A., Peacock, S., & McPherson, K. (2012). Methodological reflections on the use of asynchronous online focus groups in health research. *Int J Qual Methods* 11(4), 368–383.

[15] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qual Res Psychol* 3, 77–101.

[16] Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education Inf* 22, 63–75.

[17] Yazici, H. J. (2005). A study of collaborative learning style and team learning performance. *Education + Train* 47(3), 16–229.

[18] Freeman, M., & McKenzie, J. (2002). SPARK, a confidential web-based template for self and peer assessment of student teamwork: benefits of evaluating across different subjects. *Br J Educ Technology* 33(5), 551–569.

[19] Malamateniou, C. (2009). Radiography and research: a United Kingdom perspective. *Radiography* 1, 2–6.

[20] Council for Allied Health Professions Research (2016). Council for Allied Health Professions Research Position Statement: Developing Research Skills Within AHP Pre-registration Education. Available at: http://www.csp.org.uk/documents/cahpr-position-statement. Accessed November 10, 2016.

[21] Society and College of Radiographers (2016). Society and College of Radiographers Research Strategy [2016-2021]. London: Society and College of Radiographers.

[22] Garland, D. R., O'Connor, M. K., Wolfer, T. A., & Netting, F. E. (2006). Team based research: notes from the field. *Qual Social Work* 5(1), 94–107.

[23] Ahonen, S., & Liikanen, E. (2010). Radiographers' preconditions for evidence-based radiography. *Radiography* 16(3), 217–222.

[24] Jeffries, P. R. (2005). A framework for designing, implementing, and evaluating: simulations used as teaching strategies in nursing. *Nurs Education Perspect* 26(2), 99–103.

[25] Hayre, C. M. (2016). Cranking up, whacking up and bumping up: X-ray exposures in contemporary radiographic practice. *Radiography* 22(2), 194–198.

[26] Matthews, K., & Brennan, P. C. (2008). Optimisation of x-ray examinations: general principles and an Irish perspective. *Radiography* 15(3), 262–268.

[27] Research Design Review (2012). Interviewer Bias, Reflexivity in Qualitative Research. Available at: https://researchdesignreview.com/2012/11/14/interviewer-bias-reflexivity-in-qualitative-research/. Accessed April 10, 2017.

[28] Gilgun, J. F. (2010). Reflexivity and Qualitative Research. Current Issues in Qualitative Research, 1(2) [Kindle version]. Available at: Amazon.co.uk.

<u>Appendix 1:</u> Supplemental co-authored publication

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An observational study of cross-cultural communication in short-term, diverse professional learning groups

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An observational study of cross-cultural communication in short-term, diverse professional learning groups

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ABSTRACT

This paper reports the evaluation of a European funded 3-week summer school which took place in 2013 involving 60 staff and students from five universities. The evaluation looked at one group in detail using a qualitative approach to consider whether students and teachers can work together in multicultural groups in order to achieve their goal.

Method: One group was observed during 2 two-hour sessions of group activity; at the beginning and end of the summer school task. Video data was analysed using the Rapport Management framework, a model of cross-cultural communication, to determine what motivated this group's interactions.

Results: As the group's deadline became imminent 'face-threatening acts' (FTAs) were more apparent. These were tolerated in this group because of the development of a strong social bond. There was inequity in participation with members of the group falling into either high- or low-involvement categories. This was also well-tolerated but meant some students may not have gained as much from the experience. The group lacked guidance on managing group dynamics.

Conclusion: Cultural differences in communication were not the main threat to multi-cultural working groups. Potential problems can arise from failing to provide the group with a framework for project and team management. An emphasis on ground rules and the allocation of formal roles is important as is the encouragement of socialisation which supports the group during challenging times.

Background

For 3 weeks during August 2013, the University of Salford hosted a unique summer school programme for students and qualified radiographers, psychologists and physicists. More than sixty students and tutors from the UK, Switzerland, Norway, Portugal and the Netherlands participated (see editorial for this special edition). The programme comprised six multicultural groups each of which was required to plan and conduct an experiment related to X-ray dose and image quality and then write up their work as an article for journal submission. The project was funded through the European Commission's Erasmus Intensive programme.

Erasmus is part of the European Commission's scheme for promoting international study. The aim is to increase student mobility within the European Community[1] with the long term goal of promoting and enabling globalisation of the workforce. The Intensive Programme provides opportunities for Higher and Further Education students, teachers and institutions to work together over short periods of time, typically 3–6 weeks, to satisfy 3 objectives.[2] The study being reported here is concerned with the evaluation of the second objective which is to:

> "Enable students and teachers to work together in multinational groups and so benefit from special learning and teaching conditions not available in a single institution, and to gain new perspectives on the topic being studied"[1];

The study therefore aims to explore whether students and teachers can work together in multicultural groups in order to realise these benefits or whether cultural differences have the potential to hamper the effectiveness of the group.

Literature review

There has been much written on multicultural groups and the factors which can influence their performance. Many believe that collaboration benefits from diversity[3–6] as this promotes consideration of others' perspectives, and the more diverse these perspectives are, the richer the learning experience. Consequently it

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has been shown that diverse groups produce higher quality ideas than homogeneous groups.[7]

However, research comparing culturally homogeneous and heterogeneous groups in terms of productivity, or outputs, shows there are circumstances in which diverse groups can be less effective.[8–10] It has been suggested that this is because the benefits of diverse opinions are not always realised due to failure in communication.[11,12] These concerns relate not only to semantics i.e., language use, but to socio-pragmatic failure. Socio-pragmatics is concerned with the way people interpret meaning based on the social and cultural context in which the communication takes place. As such, because interpretations are culturally-bound, when two people from diverse cultures interact there is the potential for misinterpretation, even when a common lexicon is employed.

However, it is believed that over time adaptation to another's communication strategy occurs, enabling diverse groups to perform just as well. Watson, Kumar et al.[13] compared culturally diverse and homogeneous student groups for task performance and showed that whilst homogeneous groups performed better initially, after 17 weeks the difference in performance between the two groups was not significant.

Because the Erasmus Intensive Programme was only 3 weeks in length we were interested to know whether this would be sufficient time for the work groups to adapt in terms of communication or if socio-pragmatic failure might hinder progress and output. We therefore needed to employ a suitable tool for analysing these concerns.

Rapport Management theory

Rapport Management (RM) is a framework of cross-cultural communication.[14] It suggests the interactants (people involved in a communicative interaction) have three competing concerns during interaction i) face, ii) sociality rights and obligations and iii) interactional goal. Interactants balance these concerns through tacit communication strategies and what motivates them to prioritise one base over another is influenced by culture and context.

'Face' as described by Goffman (1967)[15] is a sociological concept related to esteem, worth and dignity and is what is claimed/protected by a person in a communicative act. However, face is both a social and a dynamic concept in that it is constructed in interaction and is determined not only by one's self-belief of what is 'face-worthy' but also by the judgement of others in the interaction. Therefore, what is worthy of approval in terms of face is dependent on many contextual factors including the perspective of each individual and the influence of wider culturally-related beliefs. A 'face-threatening act' (FTA) is experienced when a speaker makes a move which puts themselves or the hearer at risk of face loss, and like face-worthiness, what constitutes 'face loss' is also culturally bound. The RM framework further divides face into two categories: 'quality face' and 'social identify face'. The former is related to our need to be positively valued by others in terms of personal qualities. Whereas social identity face is concerned with how we are valued in the social roles we perform, i.e., our sense of public worth and is therefore particularly relevant when studying groups.

'Sociality rights' are concerned with our perceived entitlements and obligations in relationships with others. Such rights include i) 'equity' in relationships: related to a mutual understanding that there should be a balance in demands made on each other's resources, and ii) 'association', which clarifies the level of 'involvement' versus 'detachment' expected in an interaction. This can be considered in terms of either involvement in the task emotional involvement with the other interactant/s.

In addition to face and sociality rights is the 'interactional goal',[12] that is, the function or purpose of the interaction. Thus RM acknowledges the relevance of task achievement in maintaining relations since a mismatch between the importance each interactant places on the goal can cause a breakdown in communication. Linguistically, the interactional goal refers to the purpose of each individual utterance. For the purpose of this study we shall take interactional goal to be the goal or task overall, i.e. the purpose for which the group was configured.

Thus in the RM framework, face, sociality rights and interactional goal form the three main bases of communication, and it is posited that people in communicative interactions are constantly evaluating their moves according to the relative importance of these three concepts. Each person in the interaction may weigh the relative importance of the RM bases differently as a result of the influence of their own cultural and social background. In communication with someone from a different culture, what is taken as acceptable and what constitutes loss of face may not always be clear or shared. The RM framework is therefore an ideal tool for analysing culturally diverse groups.

The aim of this research was therefore to explore the influence cultural diversity might have on group collaboration and learning goal. It was not the intention to compare one national or ethnic group with another. Rather this was an exploratory study that aimed to identify whether concerns with managing rapport could interfere with task completion, and thereby to gain insight into how such groups of students might be supported. The questions which framed this research were:

- In a small intercultural learning group whose task time is limited, what motivates Rapport Management?
- Are these motivational forces influenced by changes in the group over the short time they are together?
- How can tutors facilitating short-term intercultural learning groups manage potential barriers to learning?

Method

Types of data

Observational data

One group of 7 students and 2 tutors was observed over two 2-h sessions; the first at the beginning of the project the second was during the final day of group work. There were 10 days between these two sessions, but students worked and socialised together every day during this time.

All groups were asked if they wanted to participate and only those groups where all members consented would be considered. However, in only one group did all students and tutors consent to take part. This became the study group. The demographics of the group can be found in Table 1. There were 7 students, 3 from the UK, 2 from Portugal, 1 from Switzerland and 1 from the Netherlands. There were 2 tutors, 1 from Switzerland and 1 from Portugal.

Observed interactions were captured using video camera. These interactions were not transcribed but were analysed directly from

Table 1
Participant demographics.

Participant	Country	First language	Age	Profession
Student 1	Switzerland	French	26	Radiography
Student 2	The Netherlands	Dutch	21	Radiography
Student 3	UK	English	33	Radiography
Student 4	UK	Somali	23	Radiography
Student 5	Portugal	Portuguese	21	Radiography
Student 6	Portugal	Portuguese	23	Radiography
Student 7	UK	English	24	Radiography
Tutor 1	Switzerland	French	51	Radiography
Tutor 2	Portugal	Portuguese	45	Radiography

the video to enable replay for clarification purposes (sample extracts were transcribed for illustration purposes found later in this paper). RM was used as the analytical framework to identify the motivational force for communication, in other words whether face, sociality rights or interactional goal predominated, and whether these motivational forces changed between the two sessions.

Interview data

Two of the students were interviewed for verification of researcher interpretations. Spencer Oatey (2002)[14] explains that it is the interpretation of an utterance by the people involved in an interaction which renders an utterance face-threatening, as no utterances are intrinsically face-threatening. Therefore triangulating student and researcher interpretations in this was way was important for validating the results. This task of verification requires clarification and confirmation of contextual issues not captured on video. The students were therefore interviewed together rather than individually to maximise memory of the context.

Selection of students for the interview was determined by convenience as it was necessary to interview students *after* analysis of the observational data. By this time the students had returned to their respective countries therefore it was only possible to interview UK students. Telephone interviews would have been difficult since students were required to view video clips during the interview.

Interview responses were collected as researcher notes. These were not analysed using a specific framework but were used to clarify and add verification to interpretations of the observational data.

Task

The group's task was to design and conduct an experiment to compare dose and image quality. The first week's activities were primarily individualistic, comprising didactic lectures related to underpinning knowledge. Weeks 2 and 3 were group-based and involved discussions and data collection activities. Tutors were expected to support the students in achieving their outputs. They were provided with a tutor handbook and were briefed daily about methodological issues related to the experiments, but were not given specific guidance about facilitating groups.

Ethical approval was obtained from the University of Salford Research, Innovation and Academic Engagement Ethical Approval Panel (HSCR13/39). All participants provided written consent and were assured that anonymity would be preserved. Pseudonyms have been used in the examples below.

Results

Table 2 summarises the emphasis placed on each of the RM bases by the group and how this changed between session 1 and session 2. The following will describe each session in more detail with reference to the RM bases.

Session 1 (2 h, beginning week 2)

The first recording took place in a classroom with students initially sitting in one group around a large table. The purpose of this session was for the group to design their experiment and agree how this would be conducted. The session started with the Erasmus Programme Manager (a third tutor with overall responsibility for the summer school) outlining the task to the group and clarifying concerns. The students were then left to carry on the discussion under tutor supervision. Approximately half way through the session the students began to work in small groups. There was no obvious catalyst for this tactic. In the last 20 min the students returned to their original places. One student was clarifying a task with the tutors separate from the main group. The rest of the students carried on talking quietly in pairs. Conversation in this last 20 min mainly concerned task clarification for the next day. Two students were heard to be discussing social arrangements for the evening.

Face

Quality face

There was evidence to suggest up-holding quality face of self and other was the prime concern in session 1. This manifested in Face Threatening Act (FTA) avoidance. In the following example (1 h into the session), two students from different countries are working together. One (Ben) uses English as a first language and the other (Eli) does not. The two students are discussing the notion of subjectivity in film appraisal. Ben is typing the discussion onto a laptop (numbers in brackets are pauses in seconds, square brackets are over-talking and double brackets are non-verbal actions[16]).

At line 6, Eli hesitatingly agreed with Ben although what follows shows she did not agree. She began to contradict, (which is

Table 2
Motivators for Rapport Management; comparison of both sessions.

	Quality face	Social identity face	Sociality rights		Interactional goal (task level)
			Equity (autonomy vs imposition)	Association (association vs disassociation)	
Session 1	Dominated concerns. All students protected own and others quality face. No evidence of threat to quality face.	No concerns for up-holding Social Identity Face. Evidence of tutors upholding own Social Identity Face with regard to 'traditional' tutor role	Evidence of preference for autonomy rather than imposition. Students did not appear to want to impose on others.	Evidence of disassociation. Initial signs of preference for working alone. No evidence of affective association.	Dominated motivations in terms of seeking clarity of task. Did not dominate over need to protect quality face (i.e. did not motivate face-threat)
Session 2	**Low involvement students:** concerned with protecting own face. Others did not threaten quality face of low involvement students. **High involvement students:** more willing to threaten own quality face and that of other high involvement students.	Some students who 'adopted' leadership roles were motivated to uphold Social Identity Face related to these assumed roles.	Impositions made by high involvement students but only of other high involvement students.	Most of group involved in the task. Evidence of disassociation from three students. No evidence of affective association.	Dominated motivations in terms of completing task. These concerns motivated face-threatening acts between high involvement students.

regarded as an FTA)[17] and decided to avoid this act at line 8 dismissing her interjection. This suggests she considered the threat to Ben's quality face and the threat to her own, in having to explain a tricky concept in a second language, too great and so chose an avoidance tactic instead.

1. Ben: and again it's perceptual image quality cos we're using observers
2. Eli: [[yeah]]
3. Ben: [[it's either]] perceptual or obj … subjective
4. Eli: ((thoughtful with hand on chin stroking mouth with forefinger, nods))
5. Ben: cos we'd have to specify if it's objective or subjective (2) so it's subjective
6. Eli: it's subjective (1.5) yeah ((Ben types on laptop))
7. (4)
8. Eli: but (2) no ((dismisses her comment with shake of hand – deciding not to go on))

Other FTA avoidance strategies included students not answering tutor questions, prolonged silences and individualistic activities such as some students clarifying tasks with the tutor in 'aside' conversations rather than with the rest of the group; that is talking through the tutor rather than directly to the others. There were two (UK) students who were more likely to speak out and they tended to talk to each other rather than the group. There was one Portuguese student who was also more likely to respond to tutor questions. Interview data confirmed that some of the very quiet students were lacking in confidence with their English speaking skills and the UK students admitted not wanting to expose these students' lack of English, thus showing consideration for their quality face.

Social identity face

There was little evidence of concerns for social identity face. Nobody appeared to be acting out a social role in the group such as leader, secretary etc. One student was seen to ask the tutor in a quiet voice whether the group should talk about task allocation for the following day. For this student, the need to establish social identity face was subordinated to the need not to threaten personal quality face (i.e wanting to lead but being seen by others as being 'pushy'). Interview data confirmed no roles had been defined or allocated although at various stages of the project tasks had been ascribed.

Tutors displayed behaviours typically associated with the tutor role. When students wanted some guidance with their task they would ask the tutor who would join them in their small group and answer the specific problem. Tutors also took the lead in directing discussions about the task and posing questions to the group. In this respect, the social identity face of the tutors was maintained. Interviews with the students confirmed that they thought the tutors were very effective.

Sociality rights

Association/disassociation

In terms of 'emotional' involvement, students favoured disassociation rather than association. For example, at times when the tutor were attending to individual students the rest of the group was silent (the longest silence of which was 14 min) i.e. there was little off-task discussion, and at one point one student was surreptitiously eating biscuits without sharing them. There was little evidence of warmth, humour or laughter initially, although this developed over the course of the session, especially following the small group work. This contradicts the interview data where the students believed the group had a strong social dynamic, however the interview took place several weeks after the end of the summer school so the students' perception of group rapport during the first session may have been influenced by the passage of time during which the students had engaged in social intercourse.

In terms of involvement in the task, some students demonstrated more participation than others. It is not clear what motivated this but the ones who were less involved appeared to be those who had less well-developed English skills. Lack of involvement may therefore have been related to the protection of quality face, which would have been threatened had the students been required to engage in cognitively difficult conversations that demand good spoken English.

Equity: autonomy/imposition

The preference was for students to retain autonomy in interactions rather than to be imposed upon, or to impose on others. There were very few occasions where requests were made of one another. Rather, it was the tutors who were making requests of individual students. There was no evidence that the group had formalised the concept of sociality rights through a set of ground rules or principles which would have made explicit the expected level of participation, and the acceptability of requests and challenges for getting the job done.

Interactional goal

There was a strong emphasis on the interactional goal/group task. The majority of interactions focussed towards this rather than off-task social discussion. However, despite the importance of the task for the group, the overarching theme for this first session was not to threaten quality face. Motivation for the choice of communicative strategies was therefore the preservation of quality face which had the potential to leave a task undone and therefore negatively influence the productivity of the group at this planning stage. An example of this could be seen towards the end of the session where one student raised a complex question regarding data collection points with the tutors. The rest of the students remained silent rather than joining in to help solve the problem and this silence persisted for 14 min.

Session 2 (2 h, end of week 3)

The second recording also took place in a classroom. The purpose of the session was for the students to write a joint report. Two high-involvement students sat on the back row with one of the tutors and were involved in a separate task related to the report. They talked between themselves. The rest of the students and the remaining tutor faced the front of the classroom, seated in rows rather than around a table. The report was projected onto a screen whilst one student typed up the report as it was being dictated to her. The dictation was carried out by the third (Portuguese) high-involvement student and the second tutor. The other three students were sitting around the periphery of the classroom and spoke very little during the session.

Face

Quality face

Compared to session 1, there were more instances of threat to quality face. However, these threats were only undertaken by high-

involvement students and tended to be directed at the other high-involvement students. In this example, Piri had been leading the dictation of the report, English was not her first language and she was tiring (she was heard to say she needed inspiration and kept lapsing into Portuguese). The other high-involvement students were not actively involved in dictating the report as they were completing a data analysis task. They were sitting behind Piri. The low-involvement students were not providing Piri with any help:

1. Piri: ((sighing and turning towards the back row)) shall we all look at this discussion
2. Ben: sorry I apologise
3. Piri: that's ok

Even though she emphasised the word 'all', Piri was looking for help only from the high-involvement students (she turned to face these). The low-involvement students' quality faces were therefore maintained, whilst the quality face of the high-involvement students was threatened.

Social identify face

As with session 1, there was still little evidence of concerns for social identity face because nobody had been formally allocated to a role. However, informally, role allocation was apparent. For instance, in the example above, Piri made demands of the high-involvement students and in this way she was implying they were not up-holding their social identity face, but she did not make the same demands of the low involvement students. By apologising (line 2) Ben's acknowledged this expectation and his failure in upholding his social identity face. Consequently there appeared to be an acceptance by the group that the low-involvement students were not expected to contribute, so they were not motivated by a need to uphold their social identity face. This is evidenced in the fact there were no apologies from them or any offers of help.

Sociality rights

Association/disassociation

Compared to session 1, there were more signs of affective involvement from the high-involvement students in the form of banter and joking. In this example the tutor asked Ged (a high-involvement student) whether he had finished typing up the results from the work produced by the other students

1. Tutor: you have finished the results?
2. Ged: no I didn't understand Portuguese so I couldn't
3. Tutor: oh no, ((laughter))
4. (2)
5. Piri: Google translator
6. ((Laughter from all group except two of the low-involvement students))
7. (2)
8. Ged: too much effort

Ged's response is to joke about Piri's written English, suggesting it was still in need of translation. Piri and Ged are comfortable with the banter as illustrated with the laughter. During banter between the high-involvement students the low-involvement students did not join in but smiled. Furthermore, the low-involvement students did not engage in conversation so it was difficult to identify their emotional involvement with the others and whether this had changed between the two sessions.

In terms of task involvement there appeared to be two distinct groups of students. One group comprised the three high-involvement students who tended to lead the discussion and manage the tasks. They made requests and issued instructions to one another. The low-involvement group generally observed; they appeared to be listening and were not disruptive but they did not communicate verbally and they were seen to be yawning and less-animated in their body language than the high-involvement students. The student who was typing was involved in the task but was not involved in deciding what should be written, she was following instructions only.

Equity: autonomy/imposition

As indicated above, the low-involvement students were generally not imposed upon by the high-involvement students, however as identified earlier high-involvement students expected to be imposed upon and apologised if found wanting in this regard.

Interactional goal

In this session, the interactional goal or group task appeared to be motivational driver for the communicative strategy. The group was very conscious of the deadline and this led to some face-threatening moves. In the following example, Piri was giving directions to Ida who was typing up the report.

1. Piri: so er ((pointing at screen)) when it says there continue like er almost in last paragraph continue it means that no no no down down down ((instructing Ida to scroll down the screen)
2. (1)
3. Ida: sorry? (turning round to face her)
4. Piri: when it says like there continue it means that you can put the erm that explanation you give it in the first "the possible explanation for this is the variable"
5. Ida: this one there?
6. Piri: yes because I explained that but the explanation comes afterwards

Piri used direct speech without any politeness speech modifiers but with emphasis and repetition. This can appear abrupt and face-threatening.[17] Although it is possible that Piri generally uses a more direct speech in normal speech this is not evident when comparing data from both sessions, furthermore, later in the session she justified dictating the report in a non-consensual manner to the tutor with; "I'm just saying … so we can hurry up". Student interview data confirmed that it was the pressure of the imminent deadline for the interactional goal which motivated a more direct communication strategy.

However, the interactional goal was not sufficient for low-participation students to risk threatening quality face but may have been the reason why they allowed the high-participation students to dominate and lead – they too wanted to see the task completed.

Interview data

This data was used to validate interpretations and provide further information about the group dynamic off-camera. The students reported that there was a great deal of social interaction between the members of the group outside of the recorded sessions. They had engaged in social activities (eating out, going to the pub) most nights of the programme and used on-line social networks on a regular basis which persisted at the time of the interview; several months following the end of the project. The students

described the group as very friendly and close. This appeared to contradict the observations.

When the two students were shown episodes of face threat, instigated by themselves in session 2, they were surprised and had not anticipated that their interactions would impinge on the quality face of others. They did not feel that these moves had been interpreted negatively by the other students either. They cited their continuing social networking as evidence of this view. However, they also stated that the pressure of finishing the task had driven them to make such interactional moves.

They confirmed the researcher interpretations that they had respected the sociality rights of the low-involvement students, and not impinged on their desire for autonomy, citing two reasons for this: i) some of them had shown themselves to be incapable of the task (i.e. task-specific reasons), ii) some of them had been experiencing personal difficulties (i.e. social reasons).

Discussion

The discussion will consider the three questions posed at the beginning of the study.

In the first session, this group was primarily motivated by concerns for quality face. The interactional goal was not sufficient to overcome the preference for students to protect quality face and avoid face threat. English as a second language appeared to be one of the major threats to quality face. Although this did not present barriers to communicative understanding, analysis using the RM framework showed that it influenced motivation for communication. This is because it was responsible for threatening the quality face of those students who lacked confidence in spoken English which in turn led to low-involvement, putting group productivity at risk. Students who had good spoken English were more likely to participate.

At the second session the interactional goal did drive face-threatening moves by the more dominant students, but these students were still sensitive to, and respected, the autonomy of the low-involvement students. Therefore, affective association, facilitated through the social activities arranged by the group, was implicit in the respect and sensitivity students showed to one another. It was reported in the early literature on face management that a reducing social distance (i.e. interactants becoming better acquainted socially) lessens the impact of face-threatening moves[17] so social interaction is also likely to have mitigated the FTAs between high-involvement students witnessed in the second session. Therefore a change in communication strategy between the 2 recorded sessions was apparent and appeared to be motivated by the interactional goal but, importantly, this was tolerated as a result of an enhanced emotional attachment.

Throughout the project there was no evidence of concern for social identity face (i.e. sense of public worth) and this may be because none of the students was explicitly allocated to a particular role at the beginning of the project. Furthermore there were no ground rules which, along with allocated roles, would have legitimised face threat. In other words, an allocated leader upholding their social identity face would have been expected to encourage a more equal participation, and the low-involvement students may have felt obligated to contribute. This would in turn have led to improved group efficiency rather than a polarisation of high- and low-involvement groups where some members' skills and opinions were not utilised. The importance of group ground rules to address these issues has been extensively explored and is widely advocated in the group learning literature.[11,18,19] However, for this group an unequal involvement did not lead to tensions despite a lack of rules and formalised roles because as mentioned previously socialisation outside the classroom appears to have led to a greater understanding between members.

The tutors were seen to uphold their own social identity face based on traditional assumptions of the role of the tutor. For instance, in session one, they managed the discussion, answered questions and directed and allocated tasks. In session two, the tutors were also involved in task-specific activities. The students reported that they were effective tutors. However, the tutors did not appear to give the same level of priority to the facilitation of group dynamics. For example, the tutors did not take steps to encourage the participation of low-involvement students. Lack of attention to supporting the group dynamic has been shown to have a negative impact on student motivation.[20] Tutors moving from traditional modes of teaching to more problem/project-based approaches require additional skills and a changed perspective of their role in order to facilitate effective student participation.[21,22] The tutor role therefore needs clarification and tutors may need support and training in how to manage group dynamics to ensure the task is not put at risk and that all students can benefit from participation.

There were a number of limitations to this study. The video was analysed by one (UK) researcher whose interpretation of the data is likely to have been more heavily influenced by her own cultural background. However student verification helped to support interpretations and explain the social development of the group outside the observed sessions. The group was self-selecting nevertheless the issues highlighted were not intended to be a generalisation of what would happen in all groups but an exploration of the sorts of considerations that might need to be made. Interviews with low-involvement students and tutors were not possible but could be included in evaluation of the next summer school. Observational data of any kind is subject to participant reactivity, where those being observed change behaviour as a result of being observed. However, Haidet[23] suggests that this is minimised following the initial 5 min of observation. Analysis of the two 2-h videos took this into consideration.

Conclusion and recommendations

Using the RM framework, this project explored whether objective 2 of the Erasmus Intensive summer school was achievable. It is clear that there are no cultural barriers to success for such groups and providing tutors are equipped with the skills and knowledge to support multicultural groups, new perspectives can be gained; objective two of the Erasmus Intensive Programme is therefore certainly achievable.

However the results also highlight that in order for tutors and students to work together there needs to be a clear set of roles and ground rules so that the entire group are supported in managing short term projects. Socialisation is also crucially important to enable face threatening moves, (inevitable when task deadlines are short and imminent) to be tolerated. English language skills also need some consideration. Where students are not confident in these they will need support to ensure they do not become marginalised.

Conflict of interest statement

The authors have no conflicts of interest to declare.

References

1. British Council *Erasmus* [online] http://www.britishcouncil.org/erasmus-background.htm [accessed 21.01.14].
2. British Council. *Culture AT WORK The value of intercultural skills in the workplace* [online]. IPSOS Public affairs Boos, Allen, Hamilton; 2013 [accessed 21.01.14], http://www.britishcouncil.org/culture-at-work-research_march_2013.pdf.
3. Taylor I, Burgess H. Responding to 'non-traditional' students: an enquiry and action approach. In: Boud D, Feletti G, editors. *The challenge of problem-based learning*. London: Kogan; 1997. pp. 103–16.

4. McLean MJ, van Wyk JM, Peters-Futre EM, Higgins-Opits SB. The small group in problem-based learning: more than a cognitive 'learning' experience for first-year medical students in a diverse population. *Med Teach* 2006;**28**(4): E94–103.
5. Mills PC, Woodall PF, Bellingham M, Noad M, Lloyd S. Using group learning to promote integration and cooperative learning between Asian and Australian second-year veterinary science students. *J Veterinary Med Educ* 2007;**34**(3): 350–5.
6. Singaram VS, Dolmans DHJM, Lachman N, van der Vleuten CPM. Perceptions of problem based learning (PBL) group effectiveness in a socially-culturally diverse medical student population. *Educ Health* 2008;**21**(2):1–9.
7. Oetzel JG. Self-construals, communication processes, and group outcomes in homogeneous and heterogeneous groups. *Small Group Res* 2001;**32**(1): 19–54.
8. Chatman JA, Polzer JT, Barsade SG, Neale MA. Being different yet feeling similar: the influence of demographic composition and organizational culture on work processes and outcomes. *Adm Sci Q* 1998;**43**(4):749–80.
9. Pelled LH, Eisenhardt KM, Xin KR. Exploring the black box: an analysis of work group diversity, conflict, and performance. *Adm Sci Q* 1999;**44**(1):1–28.
10. Singaram VS, van der Vleuten CPM, Stevens F, Dolmans DHJM."For most of us Africans, we don't just speak": a qualitative investigation into collaborative heterogeneous PBL group learning. *Adv Health Sci Educ* 2010:1–14.
11. Robinson L. *The influence of cultural diversity on student learning interactions: a qualitative study of rapport management in an undergraduate problem based learning group* [EdD thesis]. Huddersfield,: University of Huddersfield; 2011. pp. 1–250.
12. Spencer-Oatey H. In: *Culturally speaking: culture, communication and politeness*. London: Continuum; 2008. p.11–47.
13. Watson WE, Kumar K, Michaelsen LK. Cultural diversity's impact on interaction process and performance: comparing homogeneous and diverse task groups. *Acad Manag J* 1993;**36**(3):590–602.
14. Spencer-Oatey H. Managing rapport in talk: using rapport sensitive incidents to explore the motivational concerns underlying the management of relations. *J Pragmat* 2002;**34**(5):529–45.
15. Goffman E. *Interaction ritual. Essays on face-to-face behaviour*. New York: Pantheon; 1967.
16. Sacks H, Schegloff EA, Jefferson G. A simplistic systematics for the organisation of turn-taking for conversation. *Language* 1974;**50**(4):696–735.
17. Brown P, Levinson SC. *Politeness: some universals in language use*. Cambridge, UK: Cambridge University Press; 1987.
18. Maudsley G. Do we all mean the same thing by "problem-based learning"? A review of the concepts and a formulation of the ground rules. *Acad Med* 1999;**74**(2):178–85.
19. Azer SA. Becoming a student in a PBL course: twelve tips for successful group discussion. *Med Teach* 2004;**26**(1):12–5.
20. Mete S, Yildirim Sari H. Nursing students' expectations from tutors in PBL and effects of tutors' behaviour on nursing students. *Nurse Educ Today* 2008;**28**(4): 434–42.
21. Northedge A. Enabling participation in academic discourse. *Teach High Educ* 2003;**8**(2):169–80.
22. Moust JHC, van Berkel HJM, Schmidt HG. Signs of erosion: Reflections on three decades of problem-based learning at Maastricht University. *High Educ* 2005;**50**(4): 665–83.
23. Haidet KK, Tate J, Divirgilio-Thomas D, Kolanowski A, Happ MB. Methods to improve reliability of video-recorded behavioural data. *Res Nurs Health* 2009;**32**(4):465–74.

Appendix 2: Supplemental further work (un-published)

Development and validation of a psychometric scale for the self-assessment of research skills for undergraduate radiography students

Abstract:

Introduction: The Research-informed Teaching experience (RiTe) was developed to help create a greater understanding of research for undergraduate Diagnostic Radiography students at the University of Salford. This paper explains the development and validation of a psychometric scale for the self-assessment of research skills. Bandura's theory for self-efficacy was used as a basis for scale development.

Methods: The scale was developed using mixed methods. A pool of 20 items was created and radiography students (n=56) were asked to complete the scale following their participation with RiTe.

Results and analysis: The psychometric properties of the scale were examined using Cronbach alpha, factor analysis and item analysis. The scale was found to have a high level of internal reliability (0.7) and item analysis did not identify any redundant items. Factor analysis identified the most significant factors linked to ability to apply research skills and their use in practice.

Conclusion: Caution in interpreting and using the scale in its current format is necessary due to the limited sample size and the scale requires further testing, consequently further work is planned to determine the scale's validity. Notwithstanding this, initial findings from the scale indicate a high level of internal reliability with no redundant items. Factor analysis identified that there were two dominant factors with factor loadings above 0.4 related to ability to apply research skills and their use in practice.

Introduction:

The Research-informed Teaching experience (RiTe) integrates research and teaching within the undergraduate diagnostic radiography curriculum at the University of Salford. RiTe was developed to help create a greater comprehension and appreciation of research at undergraduate level and to facilitate undergraduate student understanding of key radiographic concepts using a Research-informed Teaching (RiT) model. Within RiTe, students learn and undertake

research relevant to their development as first post radiographers (dose optimisation and image quality) in collaborative-enquiry based learning (CEBL) groups.

Previous research has explored the student group learning experience and reactions towards RiTe and findings identified that RiTe is a valuable, relevant and interesting student learning experience constructively aligned to the learning outcomes in year 1 and 2 [1-5]. This finding is supported by qualitative research exploring academic tutor and clinical placement educator perceptions of RiTe who felt it facilitated the development of research skills, supported the development of key employability skills such as team working, and it helped with student understanding of the effects of exposure factor manipulation when minimising radiation dose and optimising image quality [6].

Although research into RiTe has evaluated the student learning experience of RiTe, it has not explored the degree to which students have acquired learning, their behaviour towards being able to apply what they have learnt both during and after qualification and the degree to which they believed RiTe helped their learning and research skill development. According to expectancy-value theory [7-8] students' beliefs concerning the degree to which they are confident in accomplishing an academic task (self-efficacy) and the degree to which they believe that the academic task is worth pursuing (task value) are two key components for understanding students' achievement behaviours and academic outcomes. This paper presents the development and validation of a psychometric scale designed to measure student task value and self-efficacy with research skills following RiTe.

Literature review:

The self-efficacy component of Albert Bandura's social-cognitive theory is believed by many to be an important theoretical contribution to the study of academic achievement, motivation, and learning [9]. Self-efficacy is defined as the belief a person has about his or her capabilities to produce the desired level of performance [10]. Self-efficacy affects how consistently and effectively people can apply what they know, making this a good predictor of performance [11]. Bandura's (1986) social learning theory provided the theoretical framework for this research and describes humans as being capable of self-regulation, planning strategies and exercising active control over responses and actions. Translated into academia this allows students to learn from their experiences and to influence their future behaviour [10].

Education sector research would seem to suggest that self-efficacy correlates positively with the achievement of outcomes. Students with a sense of high self-efficacy are more likely to be motivated to succeed when faced with potential failure [10,12]. Students' motivational beliefs and emotions therefore play a significant role in their academic achievement and engagement with learning activities. Learning that involves student participation is effective in improving student academic performance. Cognitive factors, including academic achievement and standardised test scores, receive strong emphasis in terms of measuring outcomes of success, but may have limited value in predicting future clinical performance or behaviours [13]. Self-efficacy does not necessarily equate to a general confidence in competence, but instead is more task and situation specific. Individuals can develop self-efficacy beliefs in relation to set clear, specific and challenging goals [9].

Searches in Medline, Scopus, CINAHL and Web of Science were performed over the last 5 years prior to commencing the study to see whether a similar study had been conducted. All databases returned no relevant articles when the words "self-efficacy and research skills and radiography or radiology or imaging" were searched (after exclusion of any irrelevant items or content). Self-efficacy is context specific, and therefore the use of a 'general' scale is of little use when attempting to measure a specific set of abilities or behaviours and therefore a specific scale was needed to measure the task value and self-efficacy for learning and performance with RiTe [14]. A measure of the self-efficacy of student radiographers at different stages of their training (year 1 and year 2) would also help to identify whether RiTe was associated with a high task value and positive achievement by students. This is not only important in further assessing RiTe as a learning activity, but also whether this model will contribute towards fostering professionals that value and engage with research as part of the Society and College of Radiographers Research Strategy 2016-2021 [15]**.**

Methods:

Aim:

The purpose of this study was to develop and validate a psychometric scale to capture the beliefs and attitudes of year 1 and 2 students as a predictor of future ability and knowledge with research skills following their engagement with RiTe.

The method comprised of three distinct phases – scale creation, face and construct validity and finally construct validity and reliability of the scale. The creation phase included item identification, generation and appropriateness. Ethical approval for this study was granted

(HSCR1819-035) prior to approaching participants. Permission was also sought from the Undergraduate programme leader to allow students to participate with the study.

No previous published research on a task value or self-efficacy could be found to use as a basis in the field of diagnostic radiography. However, published research does exist that has explored self-efficacy and research skills in other disciplines [11, 16-19]. As no previous literature exists in the combined fields of self-efficacy and diagnostic radiography students research skills it was not possible to build directly upon existing published research and scale items had to be created using standard theoretical principles.

Phase 1: Scale creation

Reviewing published literature [16-20] and the authors previous research findings [2-4] helped to establish a theoretical framework from which the task value and self-efficacy construct domains were proposed. Scale items were then generated for each of these domains using the literature. The scale used a six-point Likert scale, ranging from 1 strongly disagree to 6 strongly agree for each item, with four gradations between the two extremes. A Likert scale was used as it can measure qualitative qualities (e.g. attitudes, experience and opinions) and participant's responses to these in a numerical format [20-21].

Phase 2: Face and content validity

After generating the scale items, the draft scale was assessed for face and content validity via a focus group (FG) of experts who would assess the content, wording, relevance and grammar of each item. Face validity represents that the scale items will measure what it claims to be

measuring [22]. Content validity is the extent to which the scale items comprehensively represent the (main) construct of interest [14]. Once the scale items have been generated, it is important to ensure they cover the construct adequately. Any item that does not relate to the construct could lead to an error in measurement. The FG participants included a radiography academic involved with research and RiTe, and three academic staff from outside the diagnostic radiography programme (Schools of nursing, business and psychology). These participants had the range of experience and knowledge necessary to assesses the scale items. No knowledge of self-efficacy scales was presumed, but all participants were experienced academic lecturers with an interest in teaching and learning. A short explanation of the purpose of the scale with some information about self-efficacy was sent to each participant, although the psychology lecturer did have prior experience and expertise with developing psychometric scales.

A list of 20 items (10 items per construct domain) were generated in the draft scale. All FG participants contributed to the discussion and no items were added or deleted to either construct domain in the draft scale. All participants agreed that respondents would be able to comprehend the items in both constructs to correctly complete the scale and that the scale items were appropriate for the research question [23]. However, the psychology lecturer recommended that the scale needed to be more balanced with each of construct domains consisting of an equal number of positively worded and negatively-worded items (Figure 1). This change was made with the purpose of not necessarily trying to prevent acquiescent responding, but to identify and therefore and control for it [24-26].

The FG participants were given 14 days to read the items before being asked to participate with the FG. The format of the FG was via e-mail correspondence in a closed Microsoft Outlook

Group using a set of semi-structured questions to stimulate discussion. This format was used to remove timing and location constraints for participants and a set of guiding house rules were also used to outline expectations of the participants and to respect and retain confidentiality for all other participants in the FG. Discussion included the wording, relevance and scoring of the items. The researcher acted as moderator and encouraged participants to express their opinion or to give comments about the scale.

Phase 3: Construct validity and reliability of the scale

Following face and content validity testing the scale was pilot tested via a second FG. There were five participants, and the FG consisted of a recently qualified radiographer who had undertaken RiTe as student and four third year student radiographers who had recently undertaken RiTe in years 1 and 2. Again it was felt that these participants had the necessary experience and knowledge to pre-test the scale - that it displayed correctly on different platforms such as web browsers and mobile phones, ensured that potential respondents understood the wording of the scale items to avoid any misinterpretation, identify any potential problems (e.g. that it did not too long to complete the scale) and to check that the results data was meaningful. As with the first FG a short explanation of the purpose of the scale with some information about self-efficacy was sent to each pilot study participant, no experience of knowledge of self-efficacy scales was presumed. The pilot study participants were given 14 days to complete the scale before the FG was closed. The format of the FG was again via e-mail correspondence in a different closed Microsoft Outlook Group to the first FG. Discussion included how long the survey took to complete, identification of any ambiguity in the scale and clarity and presentation of the scale. All pilot study participants found each item in the scale easy to understand and complete. No issues were raised.

All answers are given using a 6-point Likert scale using one of the descriptors: 1 = strongly disagree, 2= disagree, 3 =slightly disagree, 4 =slightly agree, 5= agree, 6= strongly agree.
Value component: Task value
1. I think I will be able to use what I have learnt with this activity in other areas
2. I cannot see the benefit of research as part of my learning experience within the programme
3. I think the material in this activity is useful for me to learn
4. I do not believe research is essential for the future development of my profession
5. I do not believe it is important to encourage students to be involved with research
6. I expect to make use of research in my future career
7. I do not believe developing an understanding of research skills is important
8. I believe that it is important to be able to change practice based on research evidence
9. I do not believe working as a part of a group has helped with my learning and research skills development
10. I like the subject matter of this activity
Expectancy component: Self-efficacy for learning and performance
11. I am confident I understand the basic concepts taught in this activity
12. I lack confidence with my ability to think logically and solve problems
13. I am confident in my abilities to work with others (group work)
14. I would lack confidence if asked to apply my research skills
15. I expect to do well with the assessment in this activity
16. I lack confidence in my abilities to communicate findings to others
17. I am confident that I can master the skills taught
18. I am not confident in my ability to learn further research skills and apply these
19. I am convinced that as time goes by, having research skills will benefit me as part of my learning and professional development
20. I lack confidence in my ability to change practice based on research evidence

Figure 1: The Student Radiographer Task-Value and Self-efficacy Scale.

A purposive sampling technique was used to collect data by administering the scale to the whole year 1 and year 2 student cohort following their attendance with RiTe. The scale was distributed via an online survey (https://www.onlinesurveys.ac.uk) and closed after 5 weeks following two e-mail reminders. Year 1 and year 2 Student participation was voluntary and although written consent is not required, it was assumed that participants had consented to take part if they completed the scale. A good response rate for an unsolicited online survey has been found to be 23% to 47% [27].

Results and analysis:

Data were collected over a six-month period. At the end of this time 56 student radiographers had completed the scale. This gave a combined response rate of 57% from year 1 and year 2 cohorts at the University of Salford (Figure 2).

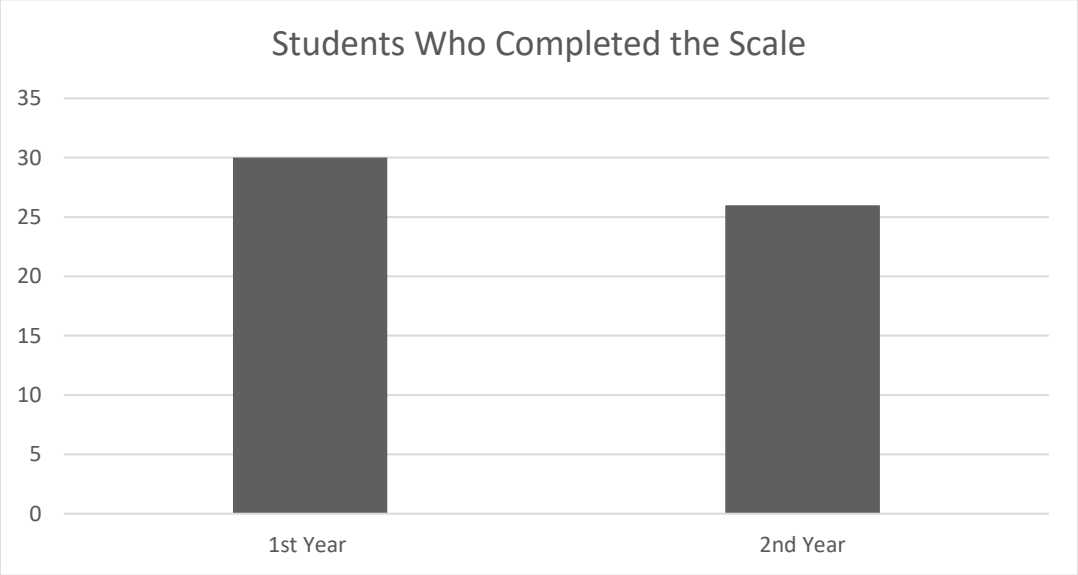


Figure 2. Distribution of sample between year cohorts.

The responses were converted into numerical scores by equating the responses with the corresponding scores. Scale items that had negative wording (e.g. “I lack confidence”, “I do not believe”) were reversed for scoring purposes so that all responses were unidirectional (i.e. a score of 6 reflected a high level of task value or self-efficacy). Aggregate scores for each respondent’s score on the 20 scale items were then calculated and there were no incomplete scales. No outliers were identified above or below the inner quartile range from the data set. A normal distribution (bell) curve was also generated and the data was found to conform closely to a normal probability distribution curve, i.e. the collected data was evenly distributed from the mean value.

Figure 3 demonstrates the two-year groups achieved similar scores on the scale. A 1-way analysis of variance (ANOVA) was performed to test whether there was a significant difference between the two groups (Table 1) and confirmed there was no statistically significant difference between the year group's response in the mean with the scale. However, self-efficacy theory would indicate that the mean scores should have increased as they progressed through undergraduate programme as the students have opportunities to learn new skills and overcome challenges as they progress through the programme [18]. This may be a consequence of the sample size, but more data collection is needed to explore this further.

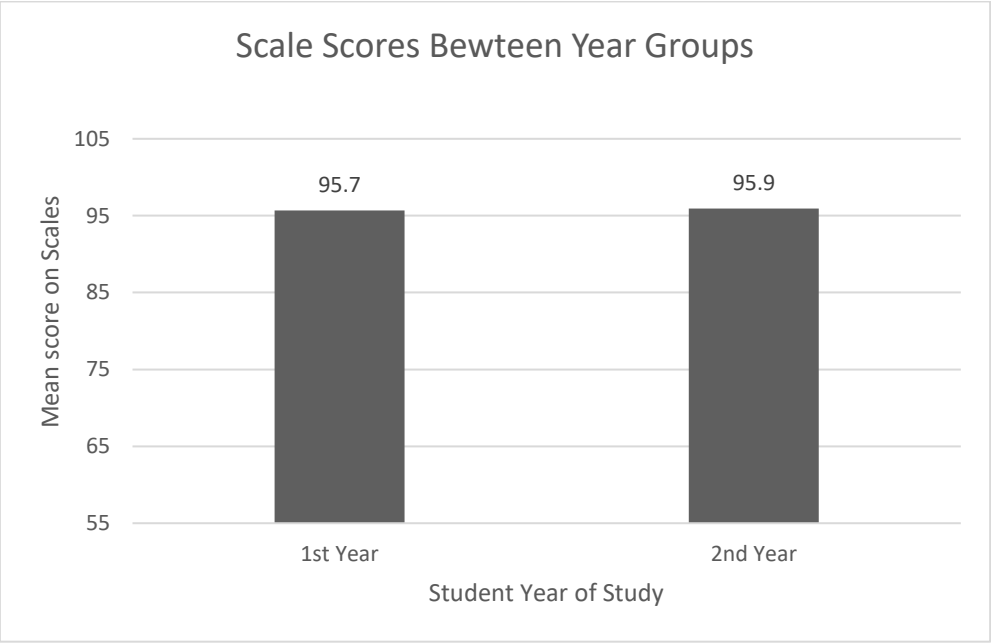


Figure 3: The difference in mean scores of the sample when split into their different year groups.

Group	Mean	SD	Significance Level
1st Year	95.70	12.90	*P*= 0.891
2nd Year	95.92	12.76	

Table 1: Results of 1-way ANOVA on scale scores for each year group.

Internal Reliability

Internal reliability is an indicator for testing consistency and is a prerequisite component for validity and how well the items correlate to one another and how well each item correlates with the total score [28-29]. Cronbach alpha coefficient was calculated to assess the internal reliability of the scale and this indicates whether scale items are consistent in measuring what they have been designed to capture. An acceptable reliability value has been suggested as 0.7 and above [28]. The Cronbach alpha coefficient for the scale was found to be 0.878, indicating that the scale demonstrated a very good level of internal reliability.

Item Analysis

Item analysis was performed to evaluate the student responses to each item on the scale in order to assess the quality of those items and of the scale as a whole. No participant responses were excluded from the analysis and all 56 participants completed all scale items. IBM SPSS Statistics (version 25) software was used to perform a reliability analysis using the scale data. This would also help to identify any redundant items that can be eliminated from the scale [11]. Item analysis identified that all scale items correlated at 0.4 or better (Table 2). No items were deleted from the scale, but more sample data is needed to analyse this further and identify any scale items that could be removed.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Question 1	90.9643	147.781	.456	.873
Question 2	90.9643	144.326	.495	.872
Question 3	91.1786	140.513	.610	.867
Question 4	90.8393	145.556	.465	.873
Question 5	90.9107	143.028	.629	.867
Question 6	91.1250	150.330	.347	.876
Question 7	90.7500	146.591	.541	.870
Question 8	90.4107	154.646	.375	.875
Question 9	91.2500	142.700	.445	.875
Question 10	91.3393	143.574	.525	.870
Question 11	90.6429	151.652	.598	.871
Question 12	90.9643	150.835	.428	.874
Question 13	90.7679	149.454	.438	.873
Question 14	91.6071	144.243	.470	.873
Question 15	90.9464	148.306	.511	.871
Question 16	91.1250	148.693	.381	.876
Question 17	90.9464	149.361	.584	.870
Question 18	91.3393	146.556	.425	.874
Question 19	90.7500	142.300	.692	.865
Question 20	91.4464	147.488	.440	.873

Table 2: Results of item analysis with all scale items.

Factor Analysis

Factor analysis (FA) was used to test the inter-correlation between items on the scale which could then be linked to represent relationships for the scale items. This would help to determine whether the variables (scale items) could be explained based on a smaller number of factors in order to validate these items that comprise the construct within the scale. This helps to uncover patterns among the variables and then clusters highly interrelated variables into factors [30].

IBM SPSS Statistics (version 25.0) software was used to perform a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The KMO statistic varies between 0 and 1, a value close to 1 indicates that patterns of correlation are compact and yield distinct and reliable factors [31]. Kaiser [32] recommends values greater than 0.5 as acceptable (any value below this might require more data collection), values between 0.5 and 0.7 are mediocre, values between 0.7 and 0.8 are good whilst values above 0.8 are very good [33]. The KMO value calculated for the scale was 0.7 which falls in the range of good and therefore we can be confident that the data correlations are compact FA is appropriate for the scale data. Bartlett's measure was also used to test the null hypothesis of the relationships between the variables. If found to be significant this would confirm that there are some relationships between the variables [31]. Bartlett's test was found to be highly significant ($p < 0.001$) and therefore FA is appropriate with this scale (Table 3).

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.697
Bartlett's Test of Sphericity	Approx. Chi-Square	583.723
	df	190
	Sig.	.000

Table 3. Kaiser-Meyer-Olkin (KMO) and Bartlett's test results.

Principal component analysis was then undertaken for FA. It was found that there were two dominant factors that accounted for 32% and 12% of the variance within the scale (Table 4). Five factors were found with an Eigenvalue >1. Fifteen factors had an Eigenvalue of <1 which was confirmed by a scree plot. These factors are too slight to be considered significant.

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	6.439	32.193	32.193
2	2.548	12.738	44.931
3	1.852	9.262	54.193
4	1.380	6.900	61.093
5	1.236	6.182	67.275
6	.964	4.822	72.097
7	.901	4.507	76.604
8	.803	4.015	80.619
9	.642	3.209	83.829
10	.557	2.787	86.616
11	.533	2.666	89.282
12	.428	2.139	91.420
13	.369	1.844	93.264
14	.314	1.572	94.836
15	.280	1.400	96.236
16	.252	1.261	97.497
17	.178	.891	98.389
18	.139	.696	99.085
19	.118	.591	99.675
20	.065	.325	100.000

Table 4. Factor analysis for an unrotated solution

To assess whether a different factor structure existed, FA was performed again on the same items but using a varimax rotation to identify whether there any underlying factors that were not apparent in the unrotated solution. Once again there were two strong factors that accounted for 32% and 12% of the variance and 5 items with an Eigenvalue of >1. The five items that loaded highly were explored to see which of the items loaded onto the factors (> 0.4). These items related to ability to apply research skills and the potential use of research skills in practice. This would seem to indicate that these are significant factors in the self-efficacy of the student radiographers.

Correlation coefficients fluctuate from sample to sample and much more in smaller samples than with a larger sample size. The reliability of FA is dependent on the sample size analysed and therefore more data needs to be collected and analysed before making any changes to the scale based on the current findings [31].

Limitations

There are only approximately 55 students per year in each University of Salford BSc (Hons) Diagnostic Radiography cohort and the overall response rate was 56 students. Further data will need to be collected over successive cohorts of year 1 and year 2 students to fully validate this scale. Participant sample size is an important element in scale validation, because of the relationship to the number of random errors that arise; the impact of random error can be minimised using large sample sizes. Reliability assessment, item and factor analysis (the statistics used for scale validation) require a minimum sample size and Spector [34] recommends a sample size of 100-200 participants. Brenowitz [35] argued that a sample size of less 100 would compromise any results. Despite a larger sample size being needed to provide more reliable results, the sample did reflect the purpose of developing and validating this scale [36-38].

The self-evaluative nature of the scale includes the possibility that some students may have evaluated their own confidence being higher than it is and it has been suggested that healthcare professionals tend to overrate their clinical knowledge, skills and/or attitudes when completing self-assessment scoring [20]. The generalisability of the scale to other Diagnostic Radiography programmes or healthcare professionals requires caution, as the scale needs further testing and development in other contexts other than RiTe.

Conclusion

The scale demonstrates a high level of internal reliability (Cronbach Alpha 0.878). This figure is above the generally accepted value of 0.7. Item analysis did not identify any redundant items on the scale and all scale items correlated at 0.4 or better. Factor analysis identified that there were two dominant factors with factor loadings above 0.4 related to ability to apply research skills and their use in practice which may indicate that these are significant factors regarding task value and self-efficacy of the student radiographers when learning research skills.

It is not possible to ascertain scale criterion validity currently within this research. The reason being no similar scale exists for self-efficacy and task value with research skills development for undergraduate Diagnostic Radiography students, so it is impossible to prove its criterion validity. To further prove the validity of the scale a larger sample needs to be used before findings can be generalised and further data collection is currently being planned. If scale validity is proved and represents task value and self-efficacy with research skills development, then further work could explore the use of the scale to establish its use in other undergraduate Diagnostic Radiography or healthcare courses.

References:

1. Higgins, R., Hogg, P. & Robinson, L. (2013a). 'Towards a research informed teaching experience within a diagnostic radiography curriculum: The level 4 (year 1) student holistic experience'. *Radiography*, 19(1): 62-66.

2. Higgins, R., Hogg, P. & Robinson, L. (2013b).'Integrating Research-informed Teaching within an Undergraduate Level 4 (year 1) Diagnostic Radiography Curriculum: A Pilot Study'. *Journal of Vocational Education*, 65(3): 351-368.

3. Higgins, R., Robinson, L. & Hogg, P. (2013c). Developing undergraduate diagnostic student radiographers' research skills using research-informed-teaching. *Imaging and Therapy Practice*, May 27-29.

4. Higgins, R., Robinson, L. & Hogg P. (2014a). 'Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum: Results from a level 4 (year 1) student cohort'. *Radiography*, 20(2): 100-106.

5. Higgins, R., Hogg, P. & Robinson, L. (2017a). 'Constructive alignment of a research-informed teaching activity within an undergraduate diagnostic radiography curriculum: A reflection', *Radiography*, 23, S30-36.

6. Higgins, R., Hogg, P. & Robinson, L. (2017b). 'Research Informed Teaching Experience in Diagnostic Radiography: Perspectives of Academic Tutors and Clinical Placement Educators'. *Journal of Medical Imaging and Radiation Sciences*, 48(23): 226-232.

7. Eccles, J.S., Adler, T.F. with the assistance of, Futterman, R., Goff, S.B., Kaczala, C.M., Meece, J.L. & Midgley, C. (1983). *Expectancies, values and academic behaviors*. In Spence, J.T. (Ed), Achievement and achievement motives (p75-146). San Francisco: W.H. Freeman.

8. Wigfield, A. & Eccles, J.S. (2000). 'Expectancy-value theory of achievement motivation'. *Contemporary Educational Psychology*, 25: 68-8.

9. Anthony R. Artino Jr, A.R (2012). 'Academic self-efficacy: from educational theory to instructional practice'. *Perspectives in Medical Education,* 1(2): 76–85.

10. Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: Freeman.

11. Rowbottom, M. & Schmitz, G.S. (2013). 'Development and validation of a student self-efficacy scale'. *Journal of Nursing Care*, 2:126. doi:10.4172/2167-1168.1000126.

12. Schunk DH. (1995). Self-efficacy and education and instruction. In Maddux, JE (Ed) *Self-efficacy, adaption and adjustment: Theory, research and application*. New York: NY: Plenum Press p281-303.

13. O'Connor et al. (2016). 'Flipping Radiology Education Right Side Up'. *Academic Radiology*, 23(7): 810-822.

14. Streiner, D & Norman GR. (2003). *Health measurement scales: A practical guide to their development and use*. 3rd ed. Oxford, England: Oxford University Press.

15. Society and College of Radiographers (2015). *Research Strategy 2016-2021*. The Society and College of Radiographers London.

16. Boswell, S.S. (2013). 'Undergraduates' perceived knowledge, self-efficacy and interest in social science research'. *The Journal of Effective Teaching*, 13(2): 48-57.

17. Earley, M.A, (2014). 'A synthesis of the literature on research methods education'. *Teaching in Higher Education*, 19:3, 245-253.

18. Kitching, J.J., Cassidy, S.F., Eachus, P. & Hogg, P. (2011). 'Creating and validating self-efficacy scales for students'. *Radiologic Technology*, 83(1):10-19.

19. Pintrinch, P.R. (1991). 'A Manual for the Use of the Motivated Strategies for Learning Questionnaire (MSLQ)'. National Center for Research to Improve Postsecondary Teaching and Learning (NCRIFFAL) and the School of Education at the University of Michigan.

20. Schroderus-Salo,T., Hirvonen, L., Henner, A,, Ahonen, S. Kaariainen, M., Miettunen, j. & Mikkonen, K. (2019). 'Development and validation of a psychometric scale for assessing healthcare professionals' knowledge in radiation protection'. Radiography, 25(2): 136-142.

21. Rattray J, Jones M.C. (2005). 'Essential elements of questionnaire design and development'. *Journal of Clinical Nursing*, 16:234-243.

22. DeVon H., Block M., Moyle-Wrigth P., Ernst D., Hayden S., Lazzara D., Savoy, S. and Kostas-Polston, E. (2007) 'A psychometric toolbox for testing validity and reliability'. *Journal of Nursing Scholarship*, (39):155-164.
23. Drennan J. (2003). 'Cognitive interviewing: verbal data in the design and pretesting of questionnaires'. *Journal of Advanced Nursing*, 42(1):57-63.

24. Cloud, J., & Vaughn, G. (1970). 'Using balanced scales to control acquiescence'. *Sociometry*, 33, 193-202.

25. Crocker, L., & Algina, J. (1986). *Introduction to classical and modern test theory*. Wadsworth Group: Belmont, CA.

26. Nunnally, J. (1978). *Psychometric Theory* (2nd ed.). New York: McGraw-Hill.

27. Nulty, D.D. (2008). 'The adequacy of response rates to online and paper surveys: What can be done?'. *Assessment & Evaluation in Higher Education*, 3: 301-314.

28. Mraity, H., England, A. & Hogg, P. (2014). Developing and validating a psychometric scale for image quality assessment. *Radiography*, 20: 306-311.

29. Striener, D., Norman G.R.& Cairney, J. (2015*). Health measurement scales: A practical guide to their development and use*. 5th ed. Oxford University Press: Oxford, England.

30. Krabbe P.F.M. (2017). *The Measurement of Health and Health Status Concepts, Methods and Applications from a Multidisciplinary Perspective*. Amsterdam: Elsevier.

31. Field, A.P. (2005). *Discovering statistics using SPSS*. 2nd edition. London: Sage.

32. Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, 39: 31–36.

33. Hutcheson, G. & Sofroniou, N. (1999). *The Multivariate Social Scientist: Introductory Statistics Using Generalized Linear Models*. Thousand Oaks, CA: Sage publications.

34. Spector, P. (1992). *Summated rating scale construction: An introduction*. California: Sage Publications.

35. Brenowitz, N. & Tutle, C. (2003). 'Development and testing of a nutrition-teaching self-efficacy scale for elementary school teachers'. *Journal of Nutritional Educational Behaviour*, 35(6): 308-311.

36. Haber, J. Sampling. in: G. LoBiondo-Wood, J. Haber (Eds.) (2006). *Nursing research – methods and critical appraisal for evidence-based practice*. Mosby Elsevier: Maryland Heights.

37. Polit, D.F. and Beck, C.T. (2012). *Nursing research: generating and assessing evidence for nursing practice.* 9th ed. Wolters Kluwer/Lippincott Williams & Wilkins: Philadelphia.

38. Lakens, D. (2012). 'Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs'. *Frontiers in Psychology*. Available from: https://www.frontiersin.org/articles/10.3389/fpsyg.2013.00863/full. [18th June 2019].

<u>Appendix 3:</u> Literature search strategy

An early review of the literature was used to establish the context and rationale for the publications and to help confirm the choice of research focus. This identified an extensive amount of pedagogical literature associated with the linking of research and teaching (for example a basic search using ProQuest Central identified 106,539 records when using the search teams "*teaching research nexus" **OR** "research informed teaching" **AND** "Higher education" **OR** "undergraduate"* published in the last 10 years).

After screening the database records key literature associated with my area of research (e.g. Healey & Jenkins, 2009) was identified and this enabled me to undertake backward reference searching (or chain searching). This helped me to explore the origins and development of research-informed teaching and identify experts, institutions or organisations that specialised in my area of research. I also identified records for backward author searching – namely R. Griffiths; G. Baldwin; A. Jenkins & M. Healy so that I could review their previous publications.

However, to better position my publications within the body of literature and the context of their contribution to understanding the phenomenon being explored in this thesis I needed to conduct a more through and strategic literature review. This is described below.

1. Sample set literature search

For my literature search I began by identifying sources for a 'sample set'. This involved citation searching using a citation database. The database used was Scopus. This database was selected due to its wide range of peer-reviewed journals in related top-level subject fields including the social sciences and health sciences. I set about identifying who had cited known relevant articles

or books linked with my area of research, which included RiT, collaborative learning, enquiry-based learning and evaluation of teaching and learning.

The following key authors were identified from this search:

- **Brew, A. (2006). Research and teaching: beyond the divide. Hampshire: Palgrave Macmillan.**
- **Baldwin, G. (2005). The teaching–research nexus: how research informs and enhances learning and teaching in the University of Melbourne. Melbourne: University of Melbourne.**
- **Brew, A. & Boud, D. (1995). Teaching and research: establishing the vital link with learning. Higher Education, 29, 261–273.**
- **Griffiths, R. (2004). Knowledge production and the research–teaching nexus: the case of the built environment disciplines. Studies in Higher Education, 29, 6, 709–726.**
- **Hattie, J. & Marsh, H. W. (1996). The relationship between teaching and research: a meta-analysis. Review of Educational Research, 66, 4, 507–542.**
- **Healey, M. (2005). Linking research and teaching exploring disciplinary spaces and the role of inquiry-based learning. In R. Barnett (Ed.), Reshaping the university: new relationships between research, scholarship and teaching (pp. 67–78). Maidenhead: McGraw-Hill/Open University Press.**
- **Healey, M. (2005). Linking research and teaching to benefit student learning. Journal of Geography in Higher Education, 29, 2, 183–201.**
- **Jenkins, A., Breen, R., Lindsay, R. & Brew, A. (2003). Re-shaping teaching in higher education: linking teaching and research. London: Kogan Page/SEDA.**
- **Jenkins, A. & Healey, M. (2005). Institutional strategies for linking teaching and research. York: The Higher Education Academy**
- **Jenkins, A., Healey, M. & Zetter, R. (2007). Linking teaching and research in disciplines and departments. York: The Higher Education Academy.**

These authors publications were then used to help me identify key theories or concepts for a ‘sample set’ of key word search terms. The purpose of developing a ‘sample set’ was to provide

a means of testing my search strategy. This would help me to identify whether my search strategy was targeted towards my topic area or was retrieving a lot of irrelevant results and therefore needed to be revised with the amendment or addition of further key words. My initial 'sample set' search terms are shown below in Table 8.

Table 8: Initial search terms for 'sample set'.

Search Concept 1	Search Concept 2	Search Concept 3
research informed teaching	collaborative learning	enquiry based learning
research teaching nexus	cooperative learning	inquiry based learning
	group learning	Problem based learning
	peer learning	

Searches were conducted using both Scopus and Google Scholar and both primary and secondary sources of information were searched. My initial literature search strategy is illustrated in Table 9.

Table 9: Initial literature search strategy used to record parameters used for 'sample set' (Adapted from Glasgow Caledonian University (no date)).

Search terms	"research informed teaching" **OR** "research teaching nexus" **AND** "collaborative learning" **OR** "cooperative learning" OR "group learning" **OR** "peer learning" **OR** "enquiry based learning" **OR** "inquiry based learning" **OR** "problem based learning"
Databases searched	Scopus Google Scholar
Part of journals searched	n/a
Years of search	1999-present
Language	English
Types of studies included	n/a
Inclusion criteria	Article Conference paper Book Book chapter Article in press Note Review
Exclusion criteria	Non-English language

Knowledge-building is usually taken to be iterative process in that researchers build on what has gone before. One dilemma I faced was how far back to go with my search as there are no fixed rules to govern this although many scientific or healthcare journals may suggest less than 10 years, as very old references may no longer be relevant or considered best practice. However, I decided to go further back than this and set my search parameters from 1999 to present as these followed recommendations for including research in undergraduate education made by the Boyer Commission in 1998.

2. Final literature search

Using these search terms Scopus returned 26 hits and Google Scholar 192 hits. Articles thought to be relevant to my areas of research were then identified and looked at to see what keywords and/or subject headings were used to help further refine my search terms as demonstrated in Table 10.

Table 10: Revised search terms for literature search.

Search Concept 1	Search Concept 2	Search Concept 3
research informed teaching	collaborative learning	enquiry based learning
research teaching nexus	cooperative learning	inquiry based learning
research based teaching	group learning	problem based learning
research led teaching	peer learning	active learning
	teamwork	

The following revised search strategy was then used: "research informed teaching" **OR** "research teaching nexus" **OR** "research based teaching" **OR** "research led teaching" **AND** "collaborative learning" **OR** "cooperative learning" **OR** "group learning" **OR** "peer learning" **OR** "teamwork" **OR** "enquiry based learning" **OR** "inquiry based learning" **OR** "problem based learning" **OR** "active learning".

The search strategy included peer reviewed journals and a combination of grey literature, books, PhD theses were also searched to reduce potential selection bias and ensure a comprehensive and objective search of the key concepts (Higgins & Green, 2011). Proquest Central, EBSCO (British Education Index, CINAHL, ERIC), Scopus, and Web of Science (formerly ISI Web of Knowledge) were used to search for relevant literature. As no two databases include the same

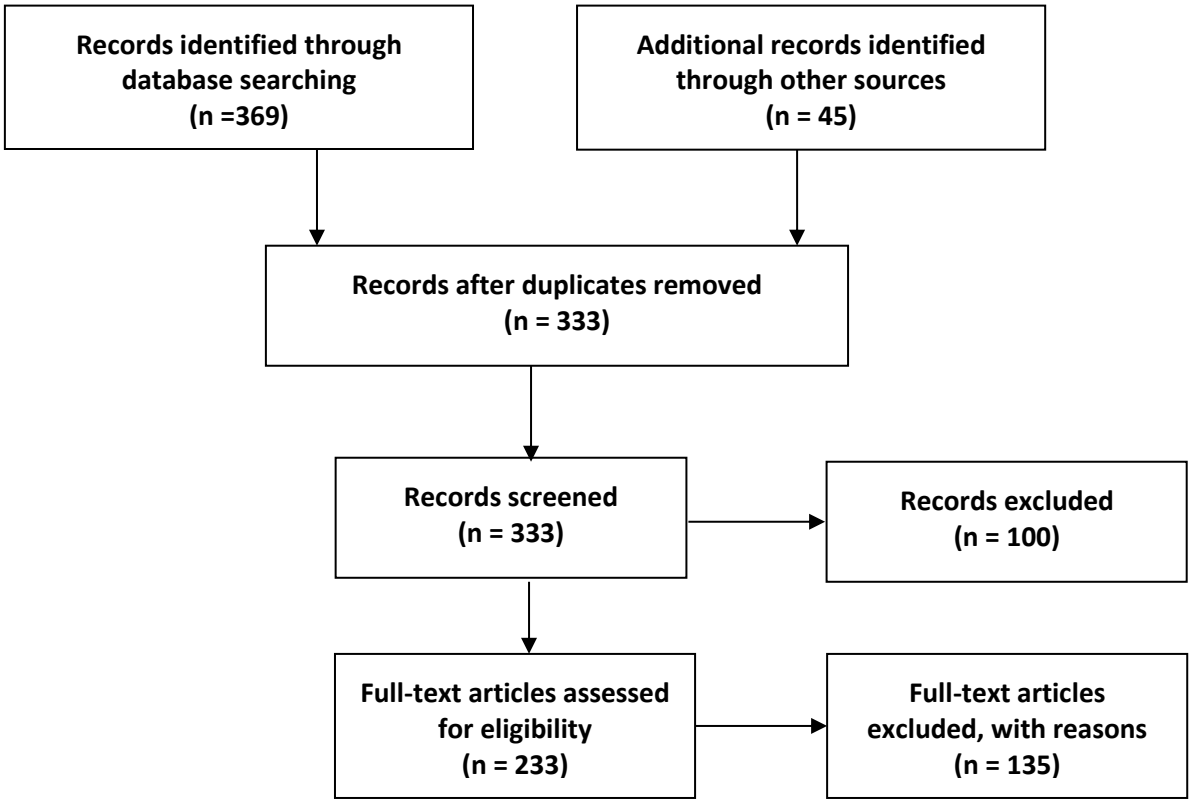
content six databases were searched to make sure I not miss any key literature during my search as illustrated in Table 11. Forward and backward searching of records of interest was undertaken along with searching the reference list of all articles for additional studies and authors. Records included in the literature review were limited to those with a relevant title (to save time and ensure validity), in English (to ensure full understanding and avoid misinterpretation) and originated from peer reviewed journals to ensure quality.

Table 11: Final literature search strategy (Adapted from Glasgow Caledonian University, no date).

Search terms	"research informed teaching" **OR** "research teaching nexus" **OR** "research based teaching" **OR** "research led teaching" **AND** "collaborative learning" OR "cooperative learning" **OR** "group learning" OR "peer learning" **OR** "teamwork" **OR** "enquiry based learning" **OR** "inquiry based learning" **OR** "problem based learning" **OR** "active learning"
Databases searched	ProQuest Central (Dissertations & Theses) ProQuest Central (Journals) EBSCO (British Education Index, CINAHL, ERIC) Scopus Web of Science (formerly ISI Web of Knowledge)
Part of journals searched	Article Title Abstract
Years of search	1999-present
Language	English
Types of studies included	Qualitative and quantitative research methods Case studies
Inclusion criteria	Peer reviewed articles Relevant title
Exclusion criteria	Not English language Non-peer reviewed articles

A comprehensive search strategy was achieved by using a combination of keywords and subject headings where possible and limiting the search parameters to English language and publication date (1999-2019). I had considered doing a further search using Google Scholar and whilst this gave me a quick overview and pointed me towards relevant material for my sample set, I felt the results may not be as comprehensive when compared to using electronic databases as there are no limits or filters. Limits were set to specific fields to search for key words in the Title/Abstract fields. In some cases, a lack of abstract meant that most of the text was reviewed in making the decision whether or not it should be included. The search outcomes are illustrated below in Figure 8.

Figure 8: Search results of ProQuest Central, EBSCO, Scopus and Web of Science databases for research informed teaching, collaborative learning and enquiry-based learning.



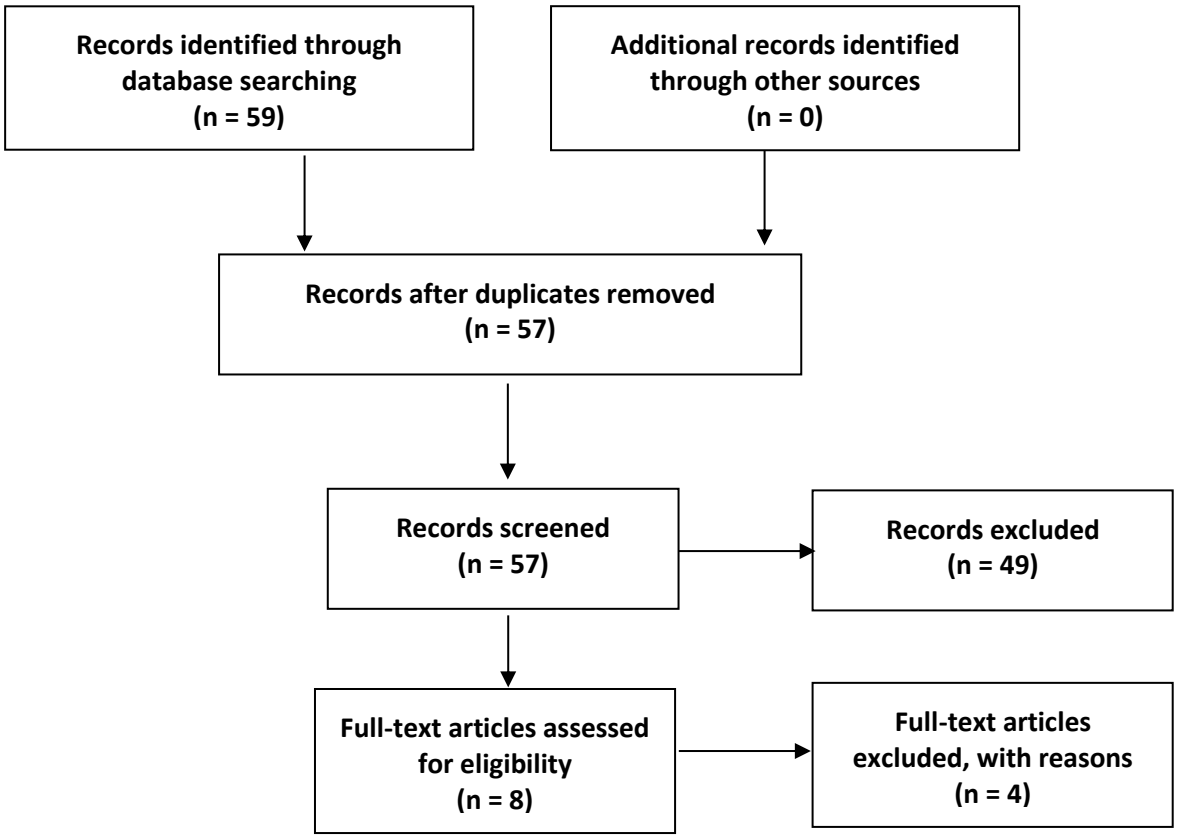
When reviewing any records, I read a description of each article and where appropriate, identified any new references cited that may be relevant (snowball). Any snowball references were then recorded for possible future use and vetted using the same procedure as articles found through the database searches.

The same approach was also used to search for literature that had explored Research-informed Teaching within radiography from 1999-2019. The following search terms were used: "research informed teaching" **OR** "research teaching nexus" **OR** "research based teaching" **OR** "research led teaching" **AND** "collaborative learning" **OR** "cooperative learning" **OR** "group learning" **OR** "peer learning*" **OR** "teamwork" **OR** "enquiry based learning" **OR** "inquiry based

learning" **OR** "problem based learning" **OR** "active learning" **AND** "radiography" **OR** "radiology" **OR** "x ray".

A search of the databases returned 58 hits, and no further hits were identified when searching for dissertations and thesis. By reviewing the hits in each database, I was also able to filter out sources that did not directly link with undergraduate radiography. The search outcomes are illustrated below in in Figure 9 which identified a limited amount of literature in this topic area, with most articles identified linked with publications on RiTe.

Figure 9: Search results of ProQuest Central, EBSCO, Scopus and Web of Science databases research informed teaching, collaborative learning, enquiry-based learning and radiography.



Appendix 4: Ethics forms for RiTe and OPTIMAX Research

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16 April 2012

Dear Robert,

RE: ETHICS APPLICATION HSCR12/12 – The RiTE Project: Integrating Teaching, Learning and Research into an undergraduate diagnostic radiography curriculum

Following your responses to the Panel's queries, based on the information you provided, I am pleased to inform you that application HSCR12/12 has now been approved.

If there are any changes to the project and/ or its methodology, please inform the Panel as soon as possible.

Yours sincerely,

Rachel Shuttleworth

Rachel Shuttleworth
College Support Officer (R&I)

University of Salford MANCHESTER

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23 July 2013

Dear Robert,

RE: ETHICS APPLICATION HSCR13/39 – The Erasmus IP Event: A study of intercultural communication in diverse professional learning groups

Based on the information you provided, I am pleased to inform you that application HSCR13/39 has now been approved.

If there are any changes to the project and/ or its methodology, please inform the Panel as soon as possible.

Yours sincerely,

Rachel Shuttleworth

Rachel Shuttleworth
College Support Officer (R&I)

University of Salford MANCHESTER

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22 March 2013

Dear Leslie, Peter and Rob,

RE: ETHICS APPLICATION HSCR13/01 – Integrating research-informed teaching within an Undergraduate Diagnostic Radiography Curriculum: the level 5 (year) Student Holistic Experience

Following your responses to the Panel's queries, based on the information you provided, I am pleased to inform you that application HSCR13-01 has now been approved.

If there are any changes to the project and/ or its methodology, please inform the Panel as soon as possible.

Yours sincerely,

Rachel Shuttleworth

Rachel Shuttleworth
College Support Officer (R&I)

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8 July 2015

Dear Robert,

RE: ETHICS APPLICATION HSCR14/103– Integrating research-informed teaching within an undergraduate diagnostic radiography curriculum

Based on the information you provided, I am pleased to inform you that your request to amend application HSCR14-103 has been approved.

If there are any changes to the project and/ or its methodology, please inform the Panel as soon as possible by contacting HSresearch@salford.ac.uk

Yours sincerely,

Sue McAndrew
Chair of the Research Ethics Panel

University of Salford MANCHESTER

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31 January 2019

Dear Rob,

RE: ETHICS APPLICATION–HSR1819-035 – 'A Research-informed Teaching Model for Undergraduate Learning and Research Skills Development Using Collaborative Enquiry Based Learning.'

Based on the information that you have provided, I am pleased to inform you that ethics application HSR1819-035 has been approved.

If there are any changes to the project and/or its methodology, then please inform the Panel as soon as possible by contacting Health-ResearchEthics@salford.ac.uk

Yours sincerely,

Professor Sue McAndrew
Chair of the Research Ethics Panel

Appendix 5: Sample extract of face-to-face focus group field notes

Date of focus group: 27/4/2012
Location of focus group: Salford University Room L621

Semi-structured questions / topics for discussion

1. Tell me about your experience of RiTe, please think broadly (holistically) when responding to this question

2. What helped you to learn during RiTe?

3. What (if anything) hindered your learning with RiTe?

4. What did you learn during RiTe?

5. Do you think your experience within RiTe will influence your approach to clinical practice?

6. What about student involvement with research?

7. Further comments and closing remarks

Question 1:

- Good experience; gained a lot working in a group
- Group project work – liked interacting with people
- Got to know people better from PBL group, splitting the PBL group (-ve experience), interesting experience and used equipment
- Hated experience – found grouping working difficult! However, did gain confidence with image appraisal
- Enjoyed it (+ve experience)
- More time needed (-ve experience)

Question 2:

- Being able to understand effects of kVp on image quality and dose. Learning about learning – team/group working
- Not sure learnt anything new in theory terms – more about research skills
- PhD student – good. Asking questions helped to reinforce theory of what was being done
- Images – gaining experience of looking at them and how to conduct image appraisal of these.

<u>Appendix 6</u>: Sample extract of verbatim data transcript from year 1 RiTe focus group (Paper 2)

Key: I = Interviewer; R1 = Respondent 1; R2 = Respondent 2; R3 = Respondent 3; R4 = Respondent 4; R5 = Respondent 5; R6 = Respondent 6; R7 = Respondent 7; R8 = Respondent 8.

Abstract:

[I: Introduces himself, goes through focus group house rules and asks respondents to reply by working around the table from right to left].

I: Tell me about your experience of RiTe 1, think broadly about your answer and share your initial experience of it.

R1: Uh…hmmm…trying to remember [Laughter]…errr… I think overall hmmm… good experience. There were one or two gripes during RiTe week, but other than that everyone seemed to enjoy it and gained a lot from it. Umm… that's it really.

I: OK.

R2: Yeah, I thought it was quite good.. errr…cause it was the first , well I know we do PBL, but we haven't actually done any group project work, so it was good to get experience of interacting with other people like that. [Pauses]. Ummm… yeah, quite interesting what we did.

R3: Hmmm… I…. feel pretty much the same. Ummm… I thought that it got … I got … to know people in my PBL group a little better. If there was one down side it was that it was it did sort of split the PBL group into definite parts and … [Pauses] and I know that some of that affected different groups, … that I didn't get to spend a lot of time with the other group, which could be a negative side to it, but I thought that it was really interesting and … sort of got a chance to use the equipment as well which is something that even though I have the skills, we have not had really a full on chance to do. So that was quite good as well.

R4: Despite everything, I hated it! [Laughter]

I: Ok! … that's alright…

R4: I…I have to confess that actually I did come out of it really feeling a load more confident about actually appraising images from an image quality point of view, so it was very good actually and helpful educationally. Despite the fact that our PBL group we all get on really, really well, I just still found the group work really difficult with [Pauses]…ummm…I think because the way our PBL group works, I tend to end up being quite a leader and I don't like to …and…so it was more to do with my personality and my issues rather than anything else with the group work, rather than the format of it. I think that's me…

R5: I actually enjoyed being a leader [Laughter]. Hmmm overall very …err… very positive experience, really good working with the group … Fantastic to get together and to do a presentation. Personally, I really enjoy presentations and I know a lot of the other people in our group were quite happy to get some presentation practice and get some confidence speaking in front of a group. [Pauses] Ummm… negative wise …I… I think it did kind of take up quite a lot of time during the week. I think it could have been something that would have been quite easily incorporated into …urrr… normal term time, the amount of time, practical time we have was literally only a day so I'm sure that they could have extended a couple of days on … during… lecture times and fit it in with normal studies and done that way, rather than taking up an entire weeks block.

R6: Yeah…right… I liked it as well because it I liked the team working and getting to know other people. I don't usually like to speak when I first see …meet people, but at the end I was the only one who was talking [Laughter].

R7: Yeah, what I really liked about it maybe is just working in my group. Some people are used to going to their kind of PBL and have their own friends, but this was a true pilot system, so you didn't have a choice to belong to a group because were are always sticking together in our own groups so at the end we made new friends. I questioned myself at the beginning as I didn't see the philosophy, and at the end I came up with 'Ok.. look.. .think twice why your are giving a dose' that was what it was all about, but giving 4mAs to a wrist did not make sense to me ……

R8: I enjoyed the week. We got on well with our side of the group, we had never worked together before and we had a good couple of laughs which was good. Ummm…we also saw some sides of people that we didn't particularly like as well [Laughter] Yeah … which maybe a positive or negative….I'm not sure. Personally, I was hoping to learn a bit more about the kVp and the interaction and something more clinical, whereas it was a very unrealistic set of parameters we were set and it was only just for that week which was not enough to produce a PowerPoint and do group work, so it would have been a bit more helpful to have been more useful for clinical, but overall I enjoyed the week.

I: Thank you. So, what do you think helped you to learn as part of the RiTe experience?

R1: Ummm….[Pauses] [Laughter] I'm not sure…

I: Is there anything that you can think of in particular that you thought that helped to reinforce maybe something that you learnt in your lectures?

R1: Ummm, I think maybe with the kVp it helped us to understand it a bit better and how it effects images and possibly dose [Pauses] Ummm…. But other than that I think it was what we were saying before because there were a number of parameters and using 4mAs a lot of the time we were questioning why are we doing this. So apart from the kVp and probably understanding it a bit better, I don't think there was much else and I think it was more learning about our individual selves and how we work in a team and our negatives and weaknesses and strengths and positives.

I: So was there anything in the way RiTe was delivered that you thought helped to facilitate learning?

R1: [Pauses] I suppose peoples' team working skills I think most of all. I know some people in our group did struggle with that working in teams which I didn't think would be an issue at all. I thought we would all be able to work just in a team, but that didn't happen. So that really…

I: Ok. Same question.

R2: Ummm… I don't really feel that I learnt anything new really. Not as in theory wise, because I think the stuff we were doing is what we had already covered. It was nice when we like got an overview of it and went over it again, but I think it was more of what you learnt ..ummm…about the research side. I thought it was more to do with getting us used to doing reports and experiments and research which I think would have been helpful, because some members of the group who don't really come from a very academic background hadn't done anything like that before, so being told do your own experiment and then this how we would do it and then going away and talking about in your groups. Having that little input was quite good, because we weren't there to learn about kVp – if we wanted to learn about kVp we could have gone to a lecture- and I think we get enough on it, but it was good to see the research side of it and a more academic rather than clinical application.

R3: Yeah, I'm similar…I learn best this way, because my background was doing sort of lab reports and things like that before, so this sort of…this…the way it was structured and just the little bits of input by PhD students and that with asking questions about the research rather than the theory…I found helped to reinforce the theory for me, because it was more why is it done that way if we are do an experiment is the way …is that the correct way to do it? When I have done anything like the SID it is set at certain distance, is there a clinical reason for that? Could we sort of go away and do some research and find out that's the way and sort of whole experiment was the exposure creep sort of thing. Is that necessarily to do with exposure creep, by actually doing experiment and questioning it helped reinforce the things for me. I thought the PhD students were really helpful … for our group anyway.

R4: I … yeah[Pauses] the thing that I think that was good educationally was the opportunity to look at loads and loads of images and keep staring at them and looking at them for graininess, for brightness all of the things we get told about in lectures, but we don't actually get to spend time looking at images and trying to see what that is in practical terms so that was the plus for me, but then by contrast because I had done a science degree before, so I had the experimental background and I already had that foundation. So for me it was more the team working and the images, rather than the how to actually conduct an experiment where as there are members of the team who come from other backgrounds, it possibly had worked better and they were learning about how to do an experiment, so it depended on what your experience was as to what you then got out of it. I also would like just to add about this comment about the 4mAs, that drove me absolutely mad! because I think almost everyone spent the whole time going 'Why are we doing this?' and it was almost like it took the focus away because it just didn't make any sense at all.

[Pause]

R5: I…like….totally agree about the other comments with regards to …ummm…experiment procedure and helping everyone to get involved and learning how to do experiments and writing about them, I think that was main point of it and was got across quite well. In terms of sort of like learning from it …what really highlighted it for me was the chance to … fire off lots of

images… you know the same thing from 40 kV right up to 120 kV, which we of course don't get to do in clinical. So it was great to see the same image at the different kVs and see the differences with different increments. Fortunately, our group had flown through the practical side and had a few hours to spare, so we ended up doing an extra experiment as well….where we did a set of values in the optimum range with 1 kV increments, and that then really highlighted to us exposure creep and sort of how pointless it at times because we just couldn't differentiate is this sort of 10 kV range between the bottom and top with the equipment plus / minus error. We couldn't differentiate between any of the .. . like… everyone came up with different orders and it was very difficult to decide between them, so that was really, really good point that was highlighted to us about exposure creep.

R6: Ummm… I agree with girls really. I didn't have any experimental background so I have learnt at lot from it. And also I think the fact that radiographic creep doesn't really … it is not really useful and it will teach us that bringing up Kv doesn't really make a difference in the image, but it does bring the patient dose high. Because we had loads of acceptable …diagnostically acceptable images with lower doses and we could actually see this with them, so I think this was good.

R7: I have a couple of notes here that I made. [Unintelligible]. Before doing this we saw images …abstract really and their use on different researches … on the internet and I wonder what this has to [Unintelligible] PhD students, what they [Unintelligible]. This research opened up my eyes to the fact that it doesn't have to be down to PhDs to do researches and ….. I wrote about what is research about and read a lot of abstracts and reviews and got to know what… how much as radiographers we … [Unintelligible] use of doses. I also discovered that [Unintelligible] most radiographers do things because they have been told that it must be done that way and they don't want to know why. [Unintelligible] I came out wanting to know more about this research. So in practice people are more concerned about beautiful images …they just want them to be beautiful so that they put the kV up and up to get them beautiful but dose is not really considered. So I think this was just an eye opener for me to be able to choose a path (research) that I would enjoy.

R8: I've done research before but not in the way we did with this, [Unintelligible] … so that was a bit a strange for me. Also … in doing the research into other peoples…. and what they had done [Unintelligible] … before in the PBL your looking for the information whereas this time we were looking at it for reasons why things are done…and …applying that to what you've done as well so I think that's a good thing.

Appendix 7: Example of coding and development of categories/themes from year 1 focus group (Paper 2)

No	CODE	MEANING
1	Positive student learning experience	Any form of evidence that linked to the statement of: Positive/good student experience
2	Negative student learning experience	Any form of evidence that linked to the statement of: Negative/poor student experience
3	Benefits (advantages)	Indication of perceived benefits with RiTe
4	Problems (disadvantages)	Indication of perceived problems or issues with RiTe
5	Teamworking / Working collaboratively	Indication of support and learning through collaboration (team working, sharing practice, knowledge sharing, discussion)
6	Contextual learning	Any form of evidence that linked to the statement of: Clinical practice and research Linking theory with practice Clinical practice
7	Research activity	Matters that are raised with student perception or involvement with research
8	Issues of acceptance	Matters that are raised on implementing RiTe or knowledge sharing in academic or clinical environment

Extracts of verbatim quotes from the participants used to illustrate the identified categories

The student holistic experience of RiTe,	Student learning and acquired knowledge following RiTe	Changes in student clinical practice following RiTe	Changes of student perception of research following RiTe
I think overall a good experience	*With the kVp it helped us to understand it a bit better and how it effects images and dose*	*It made me think before you just kind of get a twitch and not knock it up [kVp], but the way it was presented during the week, stood out for me.*	*One thing that I did learn from RiTe was that there is no research in radiography*
It was good to get experience of interacting with other people	*I think that it was good educationally. All of the things we get told about in lectures… We don't actually get to spend time looking at images and trying to see what that is in practical terms*	*No way you would say to a qualified radiographer 'Well in our RiTe week …', but it did have application, maybe it would make you think before you did it*	*When we were in, they were doing the breast tissue experiment that's [been] written up and we got to see a bit of that…It was good to see actual research being carried out as we were doing ours*
We could have done with that knowledge [Excel]…, because our side spent a lot time going this is how you use it … but we were also trying to do other things as well and it was quite difficult	*Although we are taught about it [kVp], we never really knew what difference an additional 5 [kVp] would make. Up until RiTe week, I really didn't understand it*	*You wouldn't sort of go 'You shouldn't being doing that'. So, I think from my point of view it would change my practice but I don't think I'd tell anybody else*	*It would be good to work alongside someone [doing research]*
Despite everything, I hated it!	*The whole experiment was about the exposure creep sort of thing. By actually doing the experiment and questioning it helped reinforce things for me*	*I have learned that I'm not going to bring the kVp up by 5 or whatever unless it is justified for a good reason.*	*I think it … it pushes you ahead of the crowd and you can say 'Well I've actually been picked to take part in this research and helped with this' from a sort of selfish point of view it looks good on your C.V*
Very positive experience, really good working with the group	*It will teach us that bringing up the kVp doesn't by 1 or 2 doesn't really make a difference to the image, but it does increase the patient dose*	*It's more of having self-confidence really, once your qualified you know that you have the authority to be able to help people and pass on the information that you have*	*It's going to help in the long run and make things better for the patients and make our jobs a bit easier. So I thought it was a good idea and I enjoyed it*

Appendix 8: Extracts of coding for online focus groups to help develop themes (Paper 6)

1. ACADEMIC TUTOR (AT) ONLINE FOCUS GROUP DATA

No	Analysis Notes / Initial Codes	Moderator: What is your understanding or perception of the purpose of RiTe with regards to student learning?
1.1	Research skills development (and linking this with teaching) Exposure factors, theory-practice integration	**AT A***: I understand the main purpose to be the* integration of research into teaching*. However, from a student perspective, it is probably much more than this. It should be a better appreciation of the diagnostic process and in particular exposure factors.*
1.2	Exposure factors, theory-practice integration Research skills development (and linking this with teaching) Working and learning as part of a group Enquiry-based learning helps with independent learning (links with group learning as CEBL)	**AT B***: Multiple purposes. (1) Give the students the opportunity to experiment with exposure factors so that they can see the results for themselves and therefore develop a deeper understanding of the theory;* *(2) Give students a context (which is relevant) for developing research skills and understanding the principles of a basic experimental design;* *(3) Give them the chance to work together in a group but also to develop independent learning skills via enquiry-based learning (independent of the teacher rather than of each other).(4) it was also to make more efficient use of the rooms and relieve pressure on clinical placements but this isn't related to student learning I suppose!*
1.3	Research and research skills development (and linking this with teaching) Raising awareness of research also	**AT C**: *Integrate an aspect of our research into BSc student learning* *Develop experimental science research skills in students* *Develop an appreciation of research in our students* *Develop team working skills* *Develop student presentation skills* *My perception is that it addresses all of the above and the students generally engage with it adequately*

	Team working and group learning Presentation skills (soft skill)	
1.4	Theory-practice integration Research and research skills development Linking practice-based concepts with research (evidence-based practice)	**AT D**: *My perception of RiTe is that it allows students to 'learn as they do.' It allows them to put their theories into practice and to iteratively and experimentally come up with suitable answers.*
1.5	Theory-practice integration CEBL - team working – achieving shared goals and learning Research and research skills development (and linking this with teaching)	**AT E**: *I have been quite remote from the actual design and delivery, but my understanding of RITe is that it is an opportunity to 'expose' students to practical research in a safe and interesting way. It builds on the PBL ethos of independent learning and problem solving (and enquiry-based learning), but emphasises team working in researching shared goals. Careful selection of the research problem means that the learning can be two-fold – both an understanding of the research process, but also learning that is directly related to their stage in the curriculum (eg. a physics concept).*

2. CLINICAL PLACEMENT EDUCATOR (CPE)ONLINE FOCUS GROUP DATA

No's	Analysis Notes / Initial Codes	Moderator: What is your understanding or perception of the purpose of RiTe with regards to student learning?
1.1	Research skills development Working and learning as part of a group (CEBL) Presentation skills (soft skill)	**CPE A**: *My perception of RiTE is that is enables students to learn together in a team, to plan a small research project, and to write up and present findings.*
1.2	Research and research skills development (and linking this with teaching) Theory-practice integration Team working and group learning (CEBL)	**CPE B**: *To introduce students to the concepts and practice of research* *To promote the culture of research within the radiography profession* *To develop understanding of exposure factors and radiation dose, and the effects of manipulating them* *To develop teamworking by undertaking a specific project* *To develop the ability to disseminate findings*
1.3	Team working and group learning (CEBL) Research skills development Theory-practice integration	**CPE C**: *My perception is that the students learn team work, research and presentation skills in RiTe if you are talking about the process, if you are talking about what they learn about exposure factors as that seems to be the topic usually used i am not too sure about how much they learn*

	(though not sure what they learn about this)	
1.4	Team working and group learning (CEBL) Research skills development and linking this to evidence-based practice (Theory-practice integration) Research and research skills development (and linking this with teaching	**CPE D**: *In my opinion, RiTE has many functions in terms of learning for the students. It promotes the group working ethos that they have previously experienced through PBL however they are encouraged to become more of a team with a common goal. RiTe enables them to engage with the research process by letting them try it out for themselves as opposed to reading the research of others. This helps to promote the concept of evidence-based practice which they may be unfamiliar with due to a heavy previous reliance on core texts (particularly @ level 4).*

Appendix 9: Reflections on my personal journeys

1. Autobiographical reflection

I qualified as a Diagnostic Radiographer in 1994 and worked in various hospital trusts up until March 2013 when I joined the UoS as a Lecturer in Radiography. During my career, both teaching and clinical research have informed my development towards becoming an academic within radiography.

I completed an MSc in Science and Society with the Open University in 2000 and worked as a Senior Radiographer/Research Assistant at Imperial College undertaking clinical research in bone densitometry. In 2011, I undertook the Facilitating Practice Based Learning course at Liverpool University, UK, which helped me to gain a better understanding of different teaching and learning styles, inter-professional learning and how to create an effective student-learning environment within the clinical environment. I used this knowledge to develop a student induction programme for the Imaging Department at the Clatterbridge Cancer Centre (CCC), UK and undertook clinical student assessments at CCC as an accredited Practice Educator with the College of Radiographers.

I was made an Honorary Research Fellow with the UoS, in 2009 and worked with the BSc (Hons) Diagnostic Radiography programme team to develop RiTe and have continued to be involved with this since joining as a member of the academic team in 2013. I also undertook a Postgraduate Certificate in Academic Practice (PGCAP) in 2014 to further develop my knowledge and understanding of the underpinning pedagogy of teaching, learning, and assessment and become a Fellow of the Higher Education Academy (FHEA) in 2015.

Whilst still working as a Superintendent Radiographer at CCC, I decided that I would like to pursue a full-time academic career and given my previous experience and interests wanted a position, where I would both teach and conduct research. I had previously co-authored several publications with the Research Dean at the UoS, who I had known whilst as a postgraduate student in 2004 and had come to view him as a 'mentor'. I had some informal discussions about how I might develop an academic teaching career and what the role might involve. These discussions resulted in my involvement with RiTe.

I had some pre-existing notions what my role as a lecturer might be when I joined the University in 2013, namely teaching (lectures, seminars and practical demonstrations), developing teaching materials, setting and marking assignments and exams, conducting research and carrying out administrative tasks. Based on my own past educational experiences I thought there would be a demarcation between lecturer and student interaction with the dissemination of information via didactic teaching. However, after completing my PGCAP, gaining experience with PBL facilitation and taking the lead for RiTe this view was challenged as I had come to realise that two-way dialogues with students enriched my teaching by the sharing of experiences and knowledge; for example, asking students about their experiences on placement and then sharing my experiences or stories of similar situations. This has helped me to build a strong relationship with my students during PBL through the mutual exchange of ideas and questions which in turn builds trust and enables me better to give students better constructive feedback during these sessions. This also reinforces the collaborative nature of learning which is an important element of RiTe and OPTIMAX.

Having reflected upon what I had understood previously by the terms teaching and learning, I had perhaps used these interchangeably to mean the same thing, whereas now I understand

teaching to be the action of helping another to learn and learning to be the action taken by the learner in learning (Moon, 2004). By differentiating these terms, I can come to understand that a learner can learn with or without help from a teacher (e.g. CEBL), but in my role as a teacher I can impart skills and knowledge by scaffolding the learning process by providing guided direction so that learners can demonstrate knowledge or skills.

By undertaking the research in this PhD thesis, I have gained a better understanding of RiT and how this can take different forms depending on the level engagement by students and how actively they are involved in the process of research. Using CEBL helps to increase student engagement with their subject matter by providing a student-centred approach to learning, but also several other desirable attributes such as communication skills, teamwork, problem solving, independent responsibility for learning and respect for others which are all important qualities for employability. These aspects would also seem to be highly valued by students.

I have identified further work as a post-doctoral researcher taking my research further. For example, I could use the psychometric scale currently being developed to explore student self-self-efficacy with research skills in other Diagnostic Radiography courses and how the results compare with RiTe. I also plan to explore how our research in the University can be translated into practice.

2. My PhD journey

Following my unsuccessful viva in September 2018 I have reflected on my journey. I was initially disappointed by the outcome but being able to go back and rework my thesis has in my view helped to strengthen the narrative behind the publications presented. I did not set out to complete a PhD by Published Work, this was a process that evolved as I began to further explore

RiTe and OPTIMAX. A concern raised by the external examiners at the time of my viva was stating that I had used grounded theory (GT) and that the thesis did not confirm this. At viva I was unable to defend the use of this methodology. At the outset of my research, I had read about GT and indeed mention this in my early papers as I did not find anything similar reported in the radiography literature as part of my literature review. GT is not mentioned in my later papers and following reflection I have now come to understand that my published works do not follow a GT methodology. This is because GT seeks to provide a broad theory or explanation of a process when current theories about a phenomenon are either inadequate or non-existent. The aim of my research was to gain an understanding of the underlying opinions and motivations of students when undertaking RiTe and OPTIMAX, rather than trying to generate theories based on my data. I started out using qualitative research (focus groups) and then used quantitative research (questionnaires) to quantify attitudes and opinions of RiTe identified from my qualitative research so that I could generalise my findings using a larger sample population. However, I was also interested gaining opinions from academic tutors and clinical placement educators on RiTe and OPTIMAX to provide a different perspective (teacher) and how this information might be used to develop these activities. The publications in the thesis therefore used mixed methods as a methodology and not GT to explore the participant experiences of RiTe and OPTIAMX.

Another issue raised was my understanding of key definitions or elements used in research. I now understand that a paradigm is the system of beliefs and practices shared by a group of researchers. A paradigm is a "worldview" or a set of assumptions about how things work. Rossman & Rallis (2012) define a paradigm as a "shared understandings of reality". According to Guba (1990), paradigms can be characterised through their: ontology (What is reality?), epistemology (How do you know something?) and methodology (How do go about finding

out?). These characteristics create a holistic view of how as a researcher I view knowledge and how I see myself in relation to this knowledge and the methodological strategies used. As a researcher being able to understand different research paradigms allows me to see a research question from different perspectives and how I might answer this question depending on my view of the question. This was something I had not really considered before, but now acknowledge and recognise going forward with my future research. I have taken a mixed method approach with the publications in thesis by asking participants about their experiences and views and by measuring levels of agreement to statements. Taking a pragmatic approach and using these different approaches has allowed me to explore my research from two different perspectives and therefore helped to broaden my understanding of my research phenomena. Pragmatism acknowledges that research is often multi-purpose and a "what works" tactic will allow the researcher to address questions that do not sit comfortably within a wholly quantitative or qualitative methodology and is usually associated with a mixed method research (O'Gorman & Macintosh, 2015; Rossman & Rallis, 2012; Armitage, 2007).

Another criticism of my PhD submission in September 2018 was that no search parameters were included and therefore statements could not be substantiated. I had undertaken a literature search during the writing process for my publications and development but had not documented this. Going back and undertaking a thorough survey of the literature and justifying the approach and parameters used was a helpful learning experience for me in how to generate a more in-depth argument to support the work presented in this thesis. I have gained knowledge of the importance of evaluating student satisfaction as proxy of learning through the New World Kirkpatrick Model (NWKM) of evaluation. Students' motivational beliefs and emotions play a significant role in their academic achievement and engagement with learning activities. I have come to realise that learning involves effective student participation and whilst cognitive

factors, including academic achievement and standardised test scores, receive strong emphasis in terms of measuring outcomes of success, they may have limited value in predicting future clinical performance or behaviour.

By undertaking this journey, I have also come to understand the importance of reflexivity and demonstrating trustworthiness by providing an audit trail of methods and analysis with my research. This is an important concept going forward as a researcher to help me establish credibility, confirmability and dependability with my future research publications. I have also gained an understanding of the nature of research and of the cyclical, sometimes pragmatic, nature of this process going forward as an early career researcher. For example, I have learned that things do not always fit neatly into categories and that research can be frustrating, yet at other times immensely rewarding. I have also learnt that undertaking a PhD requires a readiness to accept failure; resilience; persistence; dedication; independence; and a willingness to commit to very hard work. These are qualities that I knew I had but needed to draw upon even further for my PhD thesis resubmission. In many respects these are also key attributes required to be a researcher and this knowledge is something I will be able to pass on to my students. For example, failed experiments are the driving forces of scientific discovery, and it is acceptable to embrace failure in order to succeed by learning and reflecting on mistakes.

Appendix 10: Supportive evidence of dissemination

Further evidence is presented in this appendix to support the publications and dissemination of the research presented in this thesis which includes conference posters and presentations.

Conference presentations:

- December 2018: 'Integrating Research-informed Teaching into Radiography Education'. Achieving Excellence in Radiography Education and Research Conference, Leeds, UK.

  Awarded best proffered paper presented at the conference

- August 22nd-23rd 2018: I was invited to present and deliver a two workshop about Research-informed Teaching at Tartu Healthcare College, Estonia.

- March 2016: 'Translating our research into practice: BSc Diagnostic Radiography curriculum (and beyond!)'. Health Sciences Research Seminar. University of Salford, UK.

- December 2015: 'Integrating our research into BSc Diagnostic Radiography curriculum'. Health Science Research Centre Open Meeting: Integrating our research into our teaching. University of Salford, UK.

- January 2015: 'Developing a research culture throughout the curriculum'. European Society of Radiology. Vienna, Austria.

- March 2014: 'Integrating research and teaching within the diagnostic radiography curriculum And Evaluation of ERASMUS summer school (OPTIMAX): Student and tutor experience'. Diagnostic Imaging Research Programme (DIRP) Seminar. University of Salford, UK.

Poster presentations:

- July 2018: 'Integrating Research-informed Teaching Within the Undergraduate Diagnostic Radiography Curriculum'. Festival of Research: Research Informed Pedagogy Workshop, University of Salford, UK.

- June 2017: 'Using Research-informed Teaching experience (RiTe) to Support Learning and Practice in Undergraduate Radiography Education'. SPARC (Salford Postgraduate Annual Research Conference), Media City, University of Salford, UK.

- May 2017: 'Integrating Research-informed Teaching Within the Diagnostic Radiography Curriculum'. Early Career Researcher (ECR) Showcase, University of Salford, UK.

- November 2016: ‘Academic tutor and placement educators’ perceptions of integrating research-informed teaching within an undergraduate diagnostic radiography curriculum’. Achieving Excellence in Radiography Education and Research Conference. Birmingham Conference and Events Centre, UK. Manchester, UK.

- June 2011: ‘The RiTe project: towards a research-led curriculum in a diagnostic radiography degree’. United Kingdom Radiological Congress (UKRC).

Open Access:

The following articles were selected as part of the Journal of Medical Imaging and Radiation Sciences first e-publication entitled ‘Clinical Research’ (May 2019). This edition was based on topics related to research and research capacity:

- Research Informed Teaching Experience in Diagnostic Radiography: The Perspectives of Academic Tutors and Clinical Placement Educators
  Full length article
  Robert Higgins, Peter Hogg, Leslie Robinson
  Vol. 48, Issue 3, p226–232

- Unlocking Student Research Potential: Toward a Research Culture in Radiography Undergraduate Learning Curricular
  Editorial
  Robert Higgins, Leslie Robinson, Peter Hogg
  Vol. 46, Issue 3, S6–S9