Full Title of the Thesis

An analysis of the pedagogical concepts used by anatomy teachers to facilitate the teaching and learning of anatomy to physiotherapy undergraduates in the United Kingdom: A constructivist grounded theory study

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Acknowledgments

A doctoral thesis is a culmination of decades spent being taught through the primary school, high school, undergraduate, masters and doctoral degree educational systems. I would like to acknowledge that I benefited immensely from the academic, emotional, moral and financial support from my relatives, parents, peers, teachers, administrative and technical staff and countless well-wishers spread across three different countries where I earned my degrees.

There are two people who were influential on my entry into physiotherapy and anatomy fields. I am glad to have known Dr. Kelvin Matingo, from my childhood neighbourhood in Bulawayo, Zimbabwe, who first asked me to consider a career as a physiotherapist when I was still in high school and he was then a medical student. It was the first time I had heard of physiotherapy and I was 18 years old. I would like to acknowledge the remarkable role played by the Late Professor Laurence Fraser Levy (Levy & Levy, 2007), over a seven year period, in facilitating and mentoring my advanced anatomical training and teaching of other students at the Medical School of the University of Zimbabwe. He was one of the first neurosurgeon in Africa and was the Chairman of the Anatomy Department. He wrote my reference letter for my job application as Anatomy Lecturer at the University of East Anglia, which became my first anatomy lectureship post in the UK.

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Table of Contents

List of Appendices

Abstract

Anatomy is a challenging subject to learn because it is voluminous, requires three-dimensional cognitive skills and is easily forgotten. Furthermore, anatomy is facing diminishing teaching attention and time. There is a scarcity of literature offering pedagogical guidance for teaching anatomy for physiotherapy in the UK, despite anatomical knowledge underpinning an ever widening scope of physiotherapy. The study provides a pedagogical theory and guidance on how anatomy for physiotherapy undergraduates could be taught more effectively in the UK.

The research design generated data through in-depth semi-structured interviews with eight anatomy teachers for physiotherapy from an identified sample of 50 participants in the UK who taught anatomy modules and were registered physiotherapists. The combined interview transcripts generated 72,292 words of data that were analysed using coding techniques of grounded theory.

Chronologically, the study found that anatomy teachers explicitly taught anatomy during the 1st year, largely through practical anatomy tutorials. During the 2nd and 3rd years, clinical physiotherapy lecturers implicitly revised anatomy during their teaching sessions, while student placement supervisors implicitly reinforced anatomical knowledge and skills during hospital placements. Conceptually, five pedagogical concepts emerged that are supported by literature for medical education and were explained using the Four-Component-Instructional-Design framework derived from the Cognitive-Load theory. The anatomy-teachers-for-physiotherapy used a spirally arranged curriculum, extensive use of visual anatomical imagery, promoted kinaesthetic anatomical skills, applied anatomical knowledge and skills to physiotherapy situations and used anatomical principles for metacognitive strategies. The study deviated from the Cognitive-Load theory in three ways. The long-term memories of physiotherapy students had limited capacities that stored temporary anatomical information, instead of having unlimited capacities for permanent information. The teachers used haptic learning that is ignored by the Cognitive-Load theory. Recommendations were made on how anatomical teaching could be improved and are addressed to Anatomy Theme-Leads, anatomy-teachers-for-physiotherapy and the Chartered Society of Physiotherapy.

300 words

List of commonly used Abbreviations in the thesis

Alphabetically arranged

APTA	American Physical Therapy Association
CSP	Chartered Society of Physiotherapy
EMQ	Extended Matching Questions
FHEQ	Framework for higher education qualifications in England, Wales and Northern Ireland
HCPC	Health and Care Professions Council
MCQ	Multiple Choice Questions
NHS	National Health Service
SAQ	Short Answer Questions
WCPT	World Confederation of Physical Therapy

List of Figures used

List of Graphs used

List of Tables used

1 Introductory Chapter

1.1 General introduction to the thesis

Physiotherapy services are an integral part of the healthcare provision (Frantz, 2007) and are largely provided to patients with conditions, diseases or situations that affect movement (CSP-Scope, 2008), such as patients with a brain stroke and presenting with paralysis or arthritis on a knee joint. Some conditions that physiotherapists attend to require a good grounding in anatomical knowledge and skills, for example conditions that might require anatomical knowledge of the brain and knee joint. Consequently, anatomical education is an integral component of the undergraduate training programmes in the UK (Bithell, 2007). This chapter will make an introductory overview on the research problem and anticipated new knowledge of the thesis, my own professional reasons for undertaking the thesis and will provide an outline for the thesis.

1.2 Research problem

The main research problem that will be addressed by the study is that there is insufficient pedagogical theory guiding the teaching and learning of anatomy for physiotherapy in the UK, against a context of tremendous growth in the scope of physiotherapy services on ever increasing number of patients.

The physiotherapy profession in the UK was granted a royal charter in 1920 to train physiotherapists who worked under the orders of medical doctors (Barclay, 1994). Their physiotherapy services gradually gained credibility and recognition between the two World Wars from the medical fraternity and the public because of its efficacy based on good grounding in medical sciences and clinical knowledge (Barclay, 1994). There was a large number of soldiers and civilians injured during the Second World War requiring physiotherapy services that were funded by the government and that led to the inclusion of free (for patients) physiotherapy services as part of the newly created National Health Service (NHS) in 1948 (Barclay, 1994; Wright, 2007). The free NHS physiotherapy access for the UK public places a perpetual demand on physiotherapy schools to train more physiotherapists (Barclay, 1994; Wright, 2007). For example, there was a 72% increase in the number of UK physiotherapy students who enrolled for physiotherapy training from 1997 and 2005 (Bithell, 2007). The move to allow physiotherapists to treat patients independent of medical doctors in 1977

(Barclay, 1994) allowed for a plethora of about 50 different societies of physiotherapy specialties to flourish in the UK by 2008 (CSP-Scope, 2008).

Anatomy is defined as the structure, form and arrangements of parts (e.g. bones, arteries and nerves) that make up the human body (Standring, 2008). Anatomy is rated as the most important basic science in medical education (Pabst & Rothkötter, 1997), but is one of the most challenging to learn among medical and biological sciences (Terrell, 2006). Unfortunately, despite the growth in sophistication of physiotherapy services in the UK, there are no explicit qualitative pedagogical theories in literature that guide the teaching and learning of anatomy for physiotherapy in the UK. On the whole, there is a dearth of literature and interest on anatomical teaching for physiotherapy in the UK. The USA dominates the literature landscape of anatomy for physiotherapy, but focuses on surveying teaching practices or advocating for certain learning aids or human resources (Bacro, 2002; Bukowski, Jensen, & Morrison, 1980; Ghorbani, Karbalay-doust, & Noorafshan, 2014; Thomas, Denham, & Dinolfo, 2011; Youdas, Hoffarth, Kholwey, Kramer, & Petro, 2008), whilst largely ignoring quialitative pedagogical theories. The training of physiotherapists in the UK is highly regulated by the Chartered Society of Physiotherapy (CSP) and the Health and Care Professions Council (HCPC) (Bithell, 2007; CSP-Learning-Principles-for-Accreditation, 2011; CSP-Quality-Standards, 2012; HCPC-Conduct, 2012; HCPC-Regulation, 2015; HCPC-Training-Standards, 2009) and they place particular constraints and demands that limit the relevancy of literature from the USA. The way anatomy for physiotherapy is taught deserves robust pedagogical attention and justification because of the high cost of training physiotherapy students (McMeeken, 2008).

1.3 Anticipated contribution to the body of knowledge

The teaching and learning of anatomy for physiotherapy in the UK has not been poorly chracterised and the current study hopes to elucidate the pedagogical concepts at play and their dynamics. Throughout this current thesis, there will be a sustained focus on pedagogical concepts that will help physiotherapy students to learn anatomy more effectively. Most of the recent research on health education focuses on how learning can be more effectively taught and learnt (Bergman, Van Der Vleuten, & Scherpbier, 2011). A cognitive based theory will be proposed to explain how anatomy is learnt by physiotherapy students in the UK and will highlight the particular cognitive and metacognitive processes that result in effective anatomical learning. Pedagogical theories have the advantage of reducing the likelihood of improving learning through trial and error (Bergman et al., 2011).

The pedagogical theory that will be proposed will shed pedagogical insight on how anatomical teaching can be best arranged to optimise learning. Guidance will be offered to anatomy teachers on how they could most effectively support physiotherapy students in learning anatomy and will influence how much learning support the teachers will avail to the students and when. Anatomy is seen as a foundational subject that is meant to help the clinical practice of physiotherapy and the thesis will describe ways in which anatomical knowledge and skills could become embedded in clinical physiotherapy practice.

The study hopes to provide advice on how the various educational resources (like learning aids, time, financial and human resources) could be better used to support the effectively learning of anatomy by physiotherapy students. Implementing effective pedagogical strategies into teaching anatomy for physiotherapy could make more efficient use of limited teaching time, financial, building and human resources for teaching anatomy. New teaching and learning texts might have to be rewritten to take into account the proposed pedagogical guidance and that may include modifying existing anatomy workbooks and recommended anatomy textbooks for physiotherapy

Entrants to teaching anatomy for physiotherapy may benefit from the pedagogical guidance, while experienced teachers may be stimulated to reflect on comparing the proposed teaching strategies with their own. Promoting a coherent and explicit set of pedagogical concepts throughout an anatomy curriculum could help to reduce antagonistic tendencies among anatomy teachers who might be implementing contradictory pedagogical strategies on the same group of physiotherapy students and could potentially confuse them. The presence of a pedagogical theory offers a framework to focus academic debate among anatomy teachers for physiotherapy on how to improve educational practice in the UK.

The current study hopes to critically relate and compare pedagogical phenomenon from this thesis with existing mainstream pedagogical theories, like the Cognitive-Load theory, and explore similarities and differences. New perspectives will be revealed on the Cognitive-Load theory and other scholars may in the future find my theoretical deviations from the Cognitive-Load theory significant in their own educational contexts. A well thought-out research design will be synthesised from fundamental ontological, epistemological, methodological and method principles based on the targeted research objectives. The research design will make original and new perspectives to existing research methodologies and will adapt the classical grounded theory to suit a personal type of constructivism.

1.4 Personal professional reasons for undertaking the EdD thesis

I intentionally chose to conduct my doctoral research through a Doctorate in Education degree programme rather than through a PhD in Education because I thought I could benefit from the 'taught' and structured education modules and qualitative research skills in social sciences. In contrast, my previous professional backgrounds of physiotherapy and anatomy were anchored in hard and natural sciences. The EdD route fosters the reflection on teaching practice and better integration of theoretical perspectives in education with the practice of education in my own workplace and of other education practitioners in my field when compared to a PhD study route (Burgess, Sieminski, & Arthur, 2006). An EdD route is recommended for academics planning a career in health education and better fits in with full-time employment (Gill, Griffin, Woolf, & Cave, 2009).

The teaching of anatomy for physiotherapy ideally requires a person with a unique set of expertise from a minimum of three fields, i.e. anatomy, physiotherapy and education, of which I have. I hold a BSc Honours in Physiotherapy that enabled me to gain registration as a physiotherapist with the HCPC. I have clinical experience in most of the key branches of physiotherapy gained while working in government hospitals and private health institutions. I possess two degrees in anatomy (BSc Honours in Human Anatomy and Masters in Medicine in Anatomy degrees) and have published 14 journal publications on anatomy (Gangata, Ndou, Jooste, & Louw, 2012; Gangata, Ndou, & Louw, 2010; Gangata, Ntaba, Akol, & Louw, 2010; Gangata, 2008a, 2008b, 2009a, 2009b, 2009c, 2009d, 2010a, 2010b, 2015, 2016; Ndou, Gangata, Mitchell, Ngcongo, & Louw, 2010). I am the first anatomist from physiotherapy in Zimbabwe, as briefly described in my autobiography book cover in APPENDIX 19 on page 254. With regards to my educational credentials, I hold a Masters in Higher Education Practice that gained me Fellowship with the Higher Education Academy in 2012. I taught anatomy for over 17 years in four medical schools in three countries and nine of my journal publications are on anatomical education or anatomical administration. Two years ago in 2015, I was nominated as one of the Outstanding Teachers of the Year of the University of Birmingham after working for just eight months, as evidence of excelling in teaching (University of Birmingham, 2015) and a copy of the award letter is in APPENDIX 20 on page 255. I am now ready to bring my anatomy, physiotherapy and educational expertise together to assist the teaching and learning of anatomy for physiotherapy in the UK.

Based on my observations from the universities where I had taught, I was not content with how anatomy for physiotherapy was taught. The anatomy curriculum was usually not updated and was essentially unchanged over the years. The anatomical content taught was poorly integrated with clinical physiotherapy knowledge, in part, because anatomy for physiotherapy was taught by anatomy teachers who were not physiotherapists. I was interested in knowing how other universities were coping with the voluminous anatomical content. I was concerned about the lack of academic literature that I could use to guide my pedagogical activities for teaching anatomy for physiotherapy and I hope to generate literature that could assist other anatomy teachers.

1.5 The outline of the chapters of the thesis

The chapters of this thesis will be arranged in the following manner:

i. **Chapter 2: The Literature Review** – The chapter presents a review of what physiotherapy is, how pedagogical literature was reviewed, highlighting the major pedagogical practices in the USA and the scarcity of qualitative research into the pedagogy of teaching anatomy for physiotherapy. The information-processing cognitive theories of Ebbinghaus, Dual-Coding theory, working memory theory, Cognitive-Load theory and the Four-Component Instructional Design theory will be introduced and critically reviewed in preparation for being referred to in the Discussion Chapter used to analyse the Results Chapter.

ii. **Chapter 3: Research Design Chapter** - The chapter describes the ontological, epistemological and methodological considerations that led to the research design used in the current study. How the participants were chosen will be described together with the Research Procedure, how the interview transcripts were analysed and how the research project was administered and managed.

iii. **Chapter 4: Findings Chapter** - The chapter describes the results from the analysis of the interview transcripts. The chapter begins with describing the contextual and pedagogical background, then the Pedagogical Approaches used and when they were used. No reference to literature will be made.

iv. **Chapter 5: Discussion Chapter** – The research findings will be discussed in relation to literature. The chapter describes the five most dominant teaching strategies used by anatomy teachers for physiotherapy in the UK and will end by revealing the relationships among the strategies.

v. **Chapter 7: New knowledge, Recommendations, Personal Reflections and Conclusion Chapter** - The chapter describes the unique new contributions to the body of knowledge, recommendations to influential educational parties and my reflections on the entire EdD thesis.

1.6 Conclusion of the introductory chapter

The introductory chapter offers a bird's eye view of how the thesis will describe the main research problem, anticipated new knowledge that will emerge, my personal professional reasons for undertaking this major research project and how the thesis will be arranged. Pedagogical interest on anatomy for physiotherapy is relatively neglected in literature (McKenzie & Gutierrez, 2007; Shead, Roos, Olivier, & Ihunwo, 2016), especially in the UK, and anatomy teachers risk using inefficient strategies for teaching anatomy and having little guidance on how to be more effective in teaching within the contextual constraints of the UK. The thesis will generate a pedagogical theory of pedagogical concepts and strategies that explain the cognitive processes and their supportive practical teaching activities. The proposed pedagogical theory might influence how anatomy teachers plan, arrange and manage the learning of anatomy and use learning aids, time, financial resources and human resources. The thesis promises to have a transformative impact on my career as an anatomy lecturer at the University of Birmingham and a registered physiotherapist, and enhance my teaching and research prospects, and eventually my career progression. The following Literature Review Chapter will make a critical case for why better pedagogical theoretical frameworks and guidance from qualitative research for teaching anatomy for physiotherapy in the UK are now required.

2 Literature Review Chapter

2.1 Introduction to the Literature Review

The literature review was conducted in six stages. The initial literature review was done over a period of a year leading up to the submission of the application for a place on the EdD degree programme. It was meant to give an indication of what I intended to research on and was about four pages long. The second stage was written during the preparation and writing up of an 8,000 word module on the research design of the thesis in APPENDIX 28 on page 264. I had to discover gaps in literature on teaching and learning anatomy for physiotherapy that were worth resolving before planning a relevant and appropriate research design. The second literature review also included literature reviews around the chosen epistemological, methodological and methods of the research design. The third stage involved the submission of a full 10 000 word literature review as part of Module 5 and a copy is in APPENDIX 29 on page 299. The fourth stage was when a brief research proposal had to be submitted as part of Module 6 in APPENDIX 31 on page 359 and contained a more summarised literature review, and had to accompany the RCD1 form.

The RCD1 form was part of the internal reviewing mechanism within the Education Department of the University of Staffordshire that made sure that the planned EdD thesis met the university standards and that adequate support was in place. A copy of the completed RCD1 form is in APPENDIX 30 on page 348 together with the Departmental Approval in APPENDIX 5 on page 233. The fifth stage occurred during the coding analysis of the grounded theory methodology in response to concepts raised by participants. During this stage I searched out, identified and used a theoretical framework (of the Cognitive-Load theory and the 4CID theory) for discussing the results in the Discussion Chapter. The last phase of the literature review was when I was writing this literature review chapter.

The Google-Scholar website (Google-Scholar, 2017) and the PubMed website (Pubmed, 2017) were the primary websites used for locating relevant journal articles, books and reports. I conducted the search from my university computer and I could retrieve about 90% of the sought for papers as pdf document files. About 20 textbooks were bought over the past four years and some of the books were the latest versions in print. Freshly published literature of interest was tracked by subscribing to email alerts of the table of contents of new journal issues of the following journals: Journal of Higher Education, European Journal of Physiotherapy, Anatomical Science Education Journal, Journal of Clinical Anatomy, Journal of Medical Education and Medical Teacher Journal. In addition, I setup weekly Google Scholar email alerts to keep me abreast of new developments and themes associated with the literature review. I used Mendeley referencing software to reference literature and learnt how to programme the software to create unique new referencing formats.

In view of the five earlier literature reviews done, the current literature review will summarise the four previous literature reviews, will include new literature published since then and some of my perspectives that have changed since writing the previous literature reviews. The following literature review will aim to give the reader a condensed literature review that can stand in its own right and helps the reader to read the rest of the thesis. Initially the sixth literature review had a total of about 16000 words, despite the best of intentions of making it far smaller than this. I had to sacrifice significant portions of the literature review to end up with a shorter literature review. The following literature discussions contained within the earlier literature reviews in the various Appendices will not be repeated in this chapter:

i. Historical background of anatomy for physiotherapy - APPENDIX 29 from page 304
ii. Regulatory institutions for the physiotherapy profession in the UK - APPENDIX 31 from page 363.

The following literature review will start by exploring what physiotherapy is and then how I reviewed pedagogical literature for physiotherapy. The dominant pedagogical issues affecting the teaching and learning of anatomy for physiotherapy in the USA and the insufficiency of qualitative research on teaching anatomy for physiotherapy, especially in the UK, will follow. A critical analysis will be made of the Cognitive-Load theory and the 4CID theory (and their underlying theories) that will help explain pedagogical matters in the Discussion Chapter and lastly the weaknesses and strengths of the literature review will be deliberated.

2.2 What is physiotherapy?

The terms ‘physiotherapy’ and ‘physiotherapist’ are used in the UK (Nicholls & Cheek, 2006), Australia (Bentley & Dunstan, 2006), Africa (Frantz, 2007), India (Rai & Khatri, 2014) and Pakistan (Khan, Hussan, & Basher, 2015), and are synonyms with the terms ‘physical therapy’ and ‘physical therapist’ respectively used in the USA (Reimer, Laurenzano, & Tages, 2013) and Canada (Armstrong & Rosser, 1996).

The definition of physiotherapy is an evolving one, especially in the context of an ever widening scope of what a physiotherapist does in practice (Kersten et al., 2007; Morris et al., 2014). Various national societies of physiotherapy are affiliated to the World Confederation for Physical Therapy (WCPT) that has broadly defined physiotherapy as helping the improvement of human movement and activity and that definition ought to respect the historical definitions of physiotherapy (WCPT-Physiotherapy-Definition, 2015). The WCPT has left the national physiotherapy societies to define the scope of physiotherapy that suits their national contexts and aspirations (WCPT-Physiotherapy-Definition, 2015), and the CSP defines physiotherapy for the UK (CSP-Scope, 2008).

At the granting of the Royal Charter in 1920 to the CSP, physiotherapy practice was seen as applying physical modalities of massage, exercise and movement and 'kindred methods of treatment' to treat patients under the very specific orders of medical doctors (Barclay, 1994; Wicksteed, 1948). The phrase 'kindred methods of treatment' was an acknowledgement that the physiotherapy profession could not be comprehensively described (Barclay, 1994; CSP-Scope, 2008). The phrase 'kindred methods of treatment' was used as a vehicle for adding further physical modalities to the practice of physiotherapy during the early 20th century, such as electrotherapy (the use of electricity-based appliances that generated heat inside body tissues or stimulated nerves), joint manipulation therapy and hydrotherapy (exercises made in a swimming pool to reduce body weight) (Barclay, 1994; Downie & Boardman, 1990; Downie, 1993).

The grasp that the term 'physical technique' had in defining physiotherapy by the CSP in 2002 (CSP-Core-Standards, 2002) was dropped in 2013 (CSP-Physiotherapy-Framework-Condensed-Version, 2013) because physiotherapy could no longer be defined through physical techniques. Physiotherapists in the UK, after some further postgraduate training, can now prescribe pharmacological drugs (CSP-History, 2015; Kelly, Lau, Everheart, Lobban, & Kinsella, 2008; WCPT-Physiotherapy-Definition, 2015) and administer injections largely associated with the musculoskeletal system (CSP-History, 2015). There are physiotherapists who are called 'Extended Scope Practitioners' who can order blood tests and radiological imaging for their patients (Bithell, 2007). The emergence of 'emergency physiotherapists', who work in acute hospital settings, such as 'accident and emergency departments' (McClellan, Greenwood, & Benger, 2006; Mir et al., 2009), has loosened the tight association that chronic musculoskeletal conditions had in defining physiotherapy.

There have been fears that a narrow definition of physiotherapy could curtail what physiotherapists could do in practice when health care and its contexts are changing, although a clear and concise definition could help clarify what physiotherapy is to newly qualified physiotherapists and the public (CSP-Scope, 2008). Confusion could also arise when a physiotherapist wants to make sure that what he/she is doing is still what is acceptable for what he/she is registered to do as a physiotherapist, especially when there is now a common modern trend of blurring health related professional boundaries (CSP-Scope, 2008).

The CSP encourages physiotherapists to practice any healthcare that has a "philosophical basis of physiotherapy" p.4 (CSP-Scope, 2008), although it may be hard to justify in a court of law. The definition remains one associated with preventing, treating and evaluating health conditions and diseases associated with movement (CSP-Scope, 2008). Consequently, the breadth of the physiotherapy profession is now very wide (Latman & Lanier, 2001). I could identify 46 clinical interest and occupational groups listed in APPENDIX 1 on page 219, although there are claims that the physiotherapy groups are over 50 in number (CSP-Scope, 2008), perhaps because of counting sub-groups as groups and some may have changed names and merged with other groups since then. The groups can be roughly divided into three: population groups (children or adults etc.), speciality areas (musculoskeletal or neurology etc.) and specialisms based on treatment approachs (massage or exercise etc.) (CSP-Scope, 2008). The removal of control by the medical doctors over physiotherapists gave an impetus to encouraging specialisations and research in physiotherapy because physiotherapists could have knowledge and skills expertise that medical doctors did not have (Wright, 2007).

2.3 The Literature Review

2.3.1 Pedagogical literature on anatomy for physiotherapy

2.3.1.1 Purpose and how pedagogical literature was reviewed

In literature, there is relatively little information across the world on how anatomy for the physiotherapy profession is taught or learnt (McKenzie & Gutierrez, 2007; Shead et al., 2016) and the first ever systematic review protocol for reviewing literature on pedagogical approaches being used for teaching anatomy to physiotherapy students was only proposed last year (Shead et al., 2016). Of concern is the insufficiency of explicit pedagogical theories based on significant qualitative methodologies or interpretivist paradigms explaining how physiotherapy students learn anatomy. The poverty of qualitative methodologies or interpretivist paradigms will be argued as due to the positivism philosophy being deeply rooted, usually implicitly, into the research practices of physiotherapy as a profession, although there has been a recent minor shift towards qualitative methodologies or interpretivist paradigms, especially in the last two years. The physiotherapy profession is currently over-reliant on quantitative methodologies or positivist paradigms, which are an inefficient research tool for examining some types of educational problems, because of ontological, epistemological and method limitations. Quantitative methodologies or positivist paradigms are poor at capturing the intense interactions, and usually ignore the context and subjectiveness of knowledge (Gerrish & Lacey, 2015; Sarantakos, 2005) that are important in understanding educational phenomenon and these factors can be better examined using qualitative methodologies or interpretivist paradigms. The generation of pedagogical theories is much more effective with qualitative methodologies than quantitative methodologies (Bryman, 2012) and the advantage is enhanced when intense interactions, context and subjectivity need to be considered.

A literature search was carried out across the world on the Google Scholar (Google-Scholar, 2017) and PubMed (Pubmed, 2017) search engines that confirmed that there are insufficient pedagogical qualitative theories that could explain how anatomy for the physiotherapy profession is learnt. The limitations of literature from the UK will be hghlighted. Each of the Google Scholar and PubMed website search engines have their own advantages and disadvantages.

The Google Scholar (Google-Scholar, 2017) has an easier user interface than the PubMed search engine, but the PubMed search engine offers more precise, superior and advanced search options which may take time to master (Shultz, 2007). Unlike the PubMed search engine, the Google Scholar search engine lists grey literature, such as research reports, conference papers, books and institutional repositories, like university dissertation theses (Anders, Evans, & Rrt, 2010; Kesselman & Watstein, 2005) and makes broader multidisciplinary searches (Anders et al., 2010). The Google Scholar search engine has been criticised for including duplicates, lacking sorting options, being secretive about its search algorithm (Friend, 2006; Gardner & Eng, 2005; Giustini & Barsky, 2005; Jacsó, 2005; Mayr & Walter, 2007) and being more likely to be 'off-topic' (Shultz, 2007). The Google website includes literature links to journal papers on the Pubmed website (Shultz, 2007). The PubMed search engine accesses many databases including MEDLINE, the database of the National Library of Medicine (Anders et al., 2010), has gained worldwide respect and is one of the most regularly used search engine for literature in the biomedical field (Falagas, Pitsouni, Malietzis, & Pappas, 2008). The PubMed search engine has its own disadvantages. It typically lists fewer results than the Google Scholar search engine (Shultz, 2007), suffers from not having some journals and does not list journal manuscripts published before 1950 (Falagas et al., 2008; Shultz, 2007). Using both of the search engines helps to mask the deficiencies that each may have.

There were no time limits for the worldwide search because of limited literature on learning anatomy for physiotherapy (McKenzie & Gutierrez, 2007; Shead et al., 2016). Eight search terms were chosen to find literature on teaching and learning anatomy for physiotherapy and were inserted into both the PubMed and the Google Scholar search engines, and these are:

i. anatomy physiotherapy pedagogy teaching curriculum education
ii. anatomy physiotherapy teaching
iii. anatomy physiotherapy approaches
iv. anatomy physiotherapy teaching approach
v. anatomy physiotherapy learning approach
vi. anatomy physiotherapy learning strategy
vii. anatomy physiotherapy philosophy teaching
viii. anatomy physiotherapy teaching theory

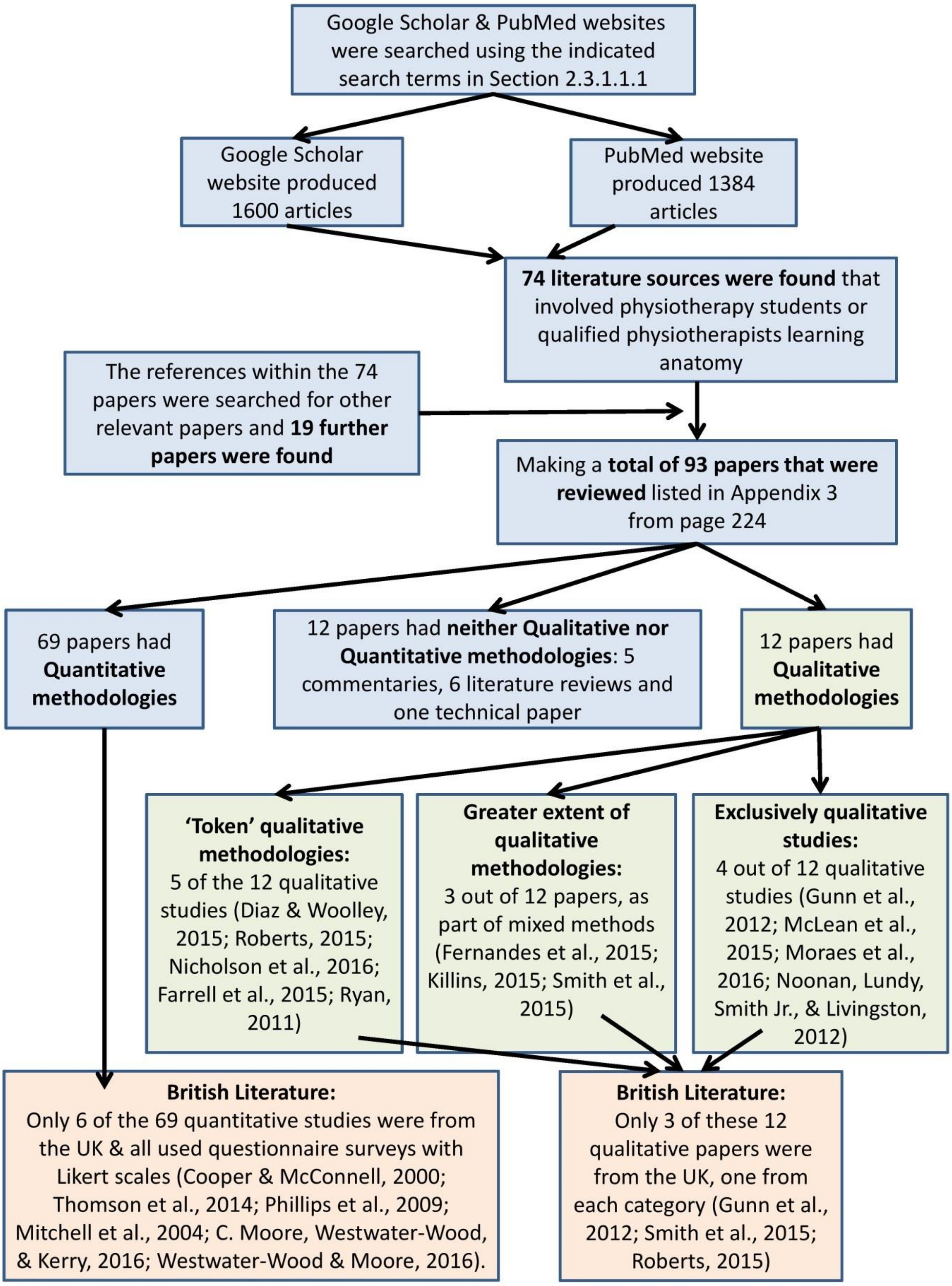
2.3.1.2 Findings of the pedagogical literature review

The number and details of research papers retrieved from both the Google Scholar and PubMed search engines are presented in APPENDIX 2 and APPENDIX 3 on page 223 and 224 respectively. Only the first 20 pages for each Google Scholar search, i.e. the first 200 entries, were examined because the total entries listed were typically over 15 000 entries for each Google Scholar search. All the search results from the PubMed were reviewed because the results listed were relatively fewer and most had less than 100 entries.

From the 2984 papers assessed from both the Google Scholar (1600 articles) and PubMed websites (1384 articles), 74 literature sources were found that involved physiotherapy students or qualified physiotherapists learning anatomy. The references within the 74 papers were searched for other relevant papers and 19 further papers were found and were added to make 93 papers. FIGURE 1 on the next page shows a flow diagram of the number of quantitative and qualitative research papers reviewed.

Most of the papers were pure quantitative studies, twelve papers were commentaries and the rest (twelve) were qualitative methodologies (some of which also had quantitative methodologies). Surveys with open ended questions, but with no qualitative methodologies to analyse them, were categorised as quantitative studies. Literature for teaching anatomy for physiotherapy as a whole was dominated by research based in the USA, and the literature from the USA is abundant enough to allow for pedagogical patterns to emerge that will be discussed the following sub-section. There will be a sub-section critically examining the deficiency of qualitative literature of teaching anatomy for physiotherapy.

Figure 1: A flow diagram of the number of quantitative and qualitative research papers reviewed



2.3.1.3 Discussion of the pedagogical literature review

2.3.1.3.1 Dominant anatomy pedagogical practices used in North America

The pedagogical principles governing the teaching of anatomy in the USA and Canada can be described as having four pillars: traditional ways of teaching anatomy, using cadaveric specimens pre-dissected before teaching sessions, teaching anatomy earlier in the physiotherapy degree programme and focussing on musculoskeletal anatomy.

Firstly, physiotherapy schools across the USA and Canada had a propensity for teaching anatomy according to how each school historically taught anatomy through teacher-centred lectures (Abdur-Rahman, 2007; Latman & Lanier, 2001; Mattingly & Barnes, 1994; Reimer et al., 2013), as was the case in Europe (Melguizo, Prados, Hita, & Peran, 2007). The scope and practice of physiotherapy has significantly widened and is challenging the adequacy of anatomical teaching based on historical practices (Mattingly & Barnes, 1994). The preponderance of literature on anatomy teaching strategies based on historical supremacy might give the impression that the “status quo” p.156 (Latman & Lanier, 2001) in pedagogy is the ‘golden standard’ for best practice and might discourage frequent reviewing of teaching. There is a shortage of anatomists (Bandaranayake, 2010; Turney, 2007), which is expected to be worse for those with physiotherapy and educational expertise, and might be stymieing the reviewing of anatomical teaching practices for physiotherapy.

Secondly, anatomy for physiotherapy is typically taught in the first year or two of physiotherapy degree programmes (Abdur-Rahman, 2007; Berube, Murray, & Schultze, 1999; Latman & Lanier, 2001; Mattingly & Barnes, 1994; Reimer et al., 2013; K. F. Shepard & Jensen, 1990; Thomas et al., 2011), and could be traced back to the influential Flexner Report (Cooke, Irby, Sullivan, & Ludmerer, 2006; Flexner, 1910; L. Miller & Weiss, 2011) that was the most important medical education document in the 20th century (L. Miller & Weiss, 2011). The American Physical Therapy Association (APTA) formally endorsed the Flexner Report (Linker, 2005), although it made the linking of anatomical knowledge to clinical physiotherapy knowledge and skills more difficult (Harden, Sowden, & Dunn, 1984). Anatomical knowledge is typically seen as a precursor and the foundational knowledge required before learning of clinical physiotherapy knowledge and skills (Mattingly & Barnes, 1994; Turney, 2007).

Thirdly, there was a widespread practice of using pre-dissected cadaveric specimens and of not making physiotherapy students actually dissect cadavers themselves (Berube et al., 1999; Reimer et al., 2013) and was similar to the practice in Japan (Kawashiro, Anahara, Kohno, Mori, & Matsuno, 2009). Pre-dissected specimens required less learning time and were cheaper to run than if the students were made to dissect themselves (Kawashiro et al., 2009; Reimer et al., 2013). Computer-based learning initiatives, used in half of physiotherapy schools in the USA, are altering the traditional way of teaching anatomy for physiotherapy (Reimer et al., 2013), but do not always produce better learning (Biasutto et al., 2006). Computer-based learning methods are seen as complementary to learning using pre-dissected specimens (Thomas et al., 2011).

The fourth pillar is that anatomical teaching in the USA is overwhelmingly focused on the musculoskeletal system (Latman & Lanier, 2001; Mattingly & Barnes, 1994). Anatomical knowledge related to human movement is central to the physiotherapy profession (Kawashiro et al., 2009; Latman & Lanier, 2001; Mattingly & Barnes, 1994; McCuskey, Carmichael, & Kirch, 2005; McMeeken, 2008; Valenza et al., 2012) because physiotherapy is broadly defined as hinging on human movement (WCPT-Physiotherapy-Definition, 2015). Anatomical knowledge on the limbs, back and neck is taught more (Latman & Lanier, 2001; Mattingly & Barnes, 1994). Consequently, physiotherapy students tend to be more knowledgeable on musculoskeletal anatomy than medical students (Valenza et al., 2012).

There is a conspicuous lack of pedagogical theories guiding the teaching of anatomy for physiotherapy in the USA and there is a tendency for anatomy teachers for physiotherapy to place emphasis on practical teaching activities. Suggestions for improving anatomical teaching for physiotherapy are usually based on using certain learning aids like computer-based resources (Bacro, 2002; Thomas et al., 2011), textbooks (Bukowski et al., 1980), or human resources such as peer-to-peer teaching (Youdas et al., 2008) or teamwork (Ghorbani et al., 2014). Each teaching resource typically has its supporters and critics (Latman & Lanier, 2001).

2.3.1.3.2 The poverty of qualitative research into the pedagogy of teaching anatomy for physiotherapy

The discussion on how the insufficiency of qualitative pedagogical research has handicapped the development of pedagogical theory will begin by summarising quantitative research. Most of the papers with a quantitative methodologies typically used Likert-based questionnaires to support the usefulness of a teaching/learning aid, such as the dissection of cadavers (Berube et al., 1999) and the use of computers based learning aids (McGown & Faust, 1971; Plack, 2000). The quantitative papers to a lesser extent explored how human resources made a positive impact on learning anatomy, such as inter-professional input (Parsell & Bligh, 1999) and peer-to-peer support (C. Moore, Westwater-Wood, & Kerry, 2016).

All the six quantitative studies from the UK used questionnaire surveys that quantified the opinions of physiotherapy students on a Likert scales. The three of the six quantitative papers showed a theme emphasis of wanting physiotherapy students to apply their anatomical knowledge on clinical situations or patients. Two of the six papers were on surface anatomy. A computer package for students was made to develop skills for assessing videos of muscle movement on living people (V. Cooper & McConnell, 2000), while the second assessed correct palpation of vertebral spines on patients (D. R. Phillips, Barnard, Mullee, & Hurley, 2009). The third study showed that physiotherapy students were prepared in anatomical knowledge and skills for their first clinical placement (Thomson et al., 2014). One paper solicited opinions from physiotherapy students on the value of learning anatomy from cadaveric dissections with other health professionals (Mitchell, McCrorie, & Sedgwick, 2004). None of the six papers made any reference to any pedagogical theory (V. Cooper & McConnell, 2000; Mitchell et al., 2004; D. R. Phillips et al., 2009; Thomson et al., 2014; Westwater-Wood & Moore, 2016), while one did (C. Moore et al., 2016).

Quantitative methodologies lack the ability to provide insight into human complexity grounded in local contexts (Bithell, 2000; Petty, Thomson, & Stew, 2012a), such as understanding the main strategies that anatomy teachers use to teach anatomy to physiotherapy students and the intricate relationships between them. The quantitative studies reviewed typically used survey questionnaires with 'straight jacket' pre-set answers that the participants could choose from and such methodologies are poorly positioned to find unexpected ideas from the participants. Pre-set answers tend to ignore the social context in which educational activities occur and are a weak methodology for explaining complex psycho-social phenomena occurring during the process of learning and teaching anatomy to physiotherapy students. Interviews are better designed to accommodate real-time exploration of ideas that a participant may raise and allow for exhaustion of those ideas before going onto the next set of ideas.

Research studies for the physiotherapy profession are profoundly dependent on quantitative methodologies (Johnson & Waterfield, 2004). For example, only 4% of papers in key physiotherapy journals had qualitative methodologies (Gibson & Martin, 2003), while virtually all the journal papers (98%) of the research on manual therapy physiotherapy up to 2011 were based on quantitative methodologies (Petty et al., 2012a). The physiotherapy profession followed the medical profession in cherishing quantitative research (such as randomised controlled trials, systematic reviews and meta-analyses) as a means of gaining broader trustworthiness (Ritchie, 1999) that suited the evaluation of new drugs, but not human interactions (Bithell, 2000).

All the twelve papers with qualitative methodologies continued the same pattern of quantitative studies of exploring the impact of human resources and learning aids on how physiotherapy students or physiotherapists learnt anatomy. Only three of these twelve qualitative papers were from the UK (Gunn, Hunter, & Haas, 2012; Roberts, 2015; Claire F. Smith, Hall, Border, Adds, & Finn, 2015), while seven of these twelve papers reported on the impact of human resources, such as inter-professional input (Fernandes, Palombella, Salfi, & Wainman, 2015; Claire F. Smith et al., 2015), feedback from anatomy teachers (McLean, Bond, & Nicholson, 2015), the role of student monitors (Moraes et al., 2016), students learning in teams (Killins, 2015) and student peer support during the learning of anatomy (Ryan, 2011). Four of the twelve qualitative studies used unspecified thematic analyses (Farrell, Davies, & Cornwall, 2015; Fernandes et al., 2015; Gunn et al., 2012; Nicholson, Reed, & Chan, 2016), while only three others specifically used grounded theory (Diaz & Woolley, 2015; Killins, 2015; Ryan, 2011; Claire F. Smith et al., 2015).

Five of the twelve qualitative studies (Diaz & Woolley, 2015; Farrell et al., 2015; Nicholson et al., 2016; Roberts, 2015; Ryan, 2011) could be argued as having ‘token’ qualitative methodologies because the qualitative data analysed was from open ended questions that formed a minor aspect of questionnaire survey forms dominated by questions with closed answer options. Three of the five ‘token’ qualitative studies made reference to pedagogical theory (Diaz & Woolley, 2015; Roberts, 2015; Ryan, 2011), while two studies did not (Farrell et al., 2015; Nicholson et al., 2016). In Australia, grounded theory was used to reveal that dynamic teachers using practical teaching activities, such as cadaveric prosections, body painting and online quizzes, promoted memorable learning through an active and experiential learning approach and was superficially linked to Kolb’s model (D. A. Kolb, 1975) of experiential learning (Diaz & Woolley, 2015). In the UK, physiotherapy students found it hard to learn anatomy independently because of insufficient tutorship guidance, and became poorly motivated to learn anatomy (Roberts, 2015). Furthermore, the independent learning did not follow the anticipated andragogy theory (E. W. Taylor & Laros, 2014). In Ireland, peer learning of anatomy was associated with better teaching and learning of anatomical knowledge, developing learning skills and a human resource for asking questions and discussion platforms (Ryan, 2011). A passing reference to the cognitive congruence and role theories (Grave, Volder, Gijselaers, & Damoiseaux, 1990) was made (Ryan, 2011).

Three other studies from the twelve qualitative studies used a greater extent of qualitative methods and the analysed data was from interviews with focus groups to complement knowledge obtained from quantitative methodologies, as part of mixed methods (Fernandes et al., 2015; Killins, 2015; Claire F. Smith et al., 2015). Two of the three studies made reference to pedagogical theory (Killins, 2015; Claire F. Smith et al., 2015), while one did not (Fernandes et al., 2015). In the USA, a PhD thesis demonstrated that a team-based learning pedagogy aided the learning of gross anatomy (Killins, 2015), although the inter-relationships among the parameters influencing the team-based learning pedagogy were not critically examined. The qualitative element of the doctoral study was pruned out in a subsequent journal paper (Huitt, Killins, & Brooks, 2015) and may indicate a lack of confidence in the qualitative component of the results. In the United Kingdom, the application of a minor qualitative work through grounded theory was used to complement the understanding of how interprofessional anatomy education encouraged participation in learning anatomy and improved teamwork and communication skills (Claire F. Smith et al., 2015). The findings were poorly discussed in relation to existing pedagogical theories. In total, eight of the twelve qualitative studies used a form of analysis of qualitative content to complement and augment quantitative data analysis.

The last four of the twelve qualitative studies were exclusively qualitative studies, with three of them employing thematic analysis and one was a case study methodology exploring many things, i.e. like how anatomical teaching could improve retention of physiotherapy students and used no specific experimental design (Noonan, Lundy, Smith Jr., & Livingston, 2012). The three fully fledged standalone qualitative studies with thematic analyses analysed transcripts generated from extensive interviews with individuals (Gunn et al., 2012; McLean et al., 2015) or analysed essays (Moraes et al., 2016). In the UK, a pure qualitative study examined the impact of the Problem-based Learning philosophy/theory on how physiotherapy students learnt anatomy during clinical placements (Gunn et al., 2012). Although learning anatomy was not one of the objectives of the study, it emerged from the data coding that physiotherapy student supervisors had low confidence in using the Problem-Based Learning theory to teach anatomical knowledge and skills (Gunn et al., 2012). In New Zealand, the ways in which physiotherapy students experienced the different uses and meanings of feedback were explored through phenomenology (McLean et al., 2015). Feedback was seen as telling, guiding, developing understanding and opening up new perspectives and was linked to many pedagogical theories (McLean et al., 2015), such as Kember's 'teacher-centred' teaching (Kember, 1997). In Brazil, exploratory descriptive analysis of essay reports by student monitors described the importance of cadaveric dissection and no reference was made in relation to any known pedagogical theory (Moraes et al., 2016).

None of the papers provided effective strategies that could over arch and tie together most of the teaching activities across the three undergraduate years. Most of the twelve studies with qualitative methodologies did not critically engage with literature of established pedagogical theories and typically used a couple of sentences to link their results to a particular pedagogical theory. There is evidence that the teaching of anatomy for physiotherapy does not follow andragogy theory (E. W. Taylor & Laros, 2014) or Problem-Based Learning theory (Gunn et al., 2012). Of the twelve studies, four did not refer to any pedagogical theory at all (Farrell et al., 2015; Fernandes et al., 2015; Moraes et al., 2016; Nicholson et al., 2016), while none of the twelve studies generated a new pedagogical theory to explain how anatomy was learnt by physiotherapists. The only full blown qualitative study from the UK excluded the Problem-Based Learning philosophy and gave no alternatives (Gunn et al., 2012) and left a void on the pedagogical theory that could be at play in British physiotherapy students learning anatomy. The unease by the physiotherapy profession to run anatomy pedagogical research based largely on qualitative methodologies curtailed the generation of pedagogical theory.

The first small wave of twelve pedagogical qualitative studies were mostly published in the last two years (Diaz & Woolley, 2015; Farrell et al., 2015; Fernandes et al., 2015; Killins, 2015; McLean et al., 2015; Moraes et al., 2016; Nicholson et al., 2016; Roberts, 2015; Claire F. Smith et al., 2015), except for two from the period 2011-2012 (Gunn et al., 2012; Ryan, 2011). The start of the publication of ten of the above twelve qualitative papers coincide with the year when my ethics approval was granted and data collected for the current thesis in 2015, as indicated in the Research Timeline in TABLE 6 and TABLE 7 starting from page 66. The recent emergence of qualitative methodologies at the expense of quantitative methodologies highlights deeper philosophical tensions within the physiotherapy profession between scholars of positivism and scholars of the post-positivist era (Petty et al., 2012a; Petty, Thomson, & Stew, 2012b; Katherine F. Shepard, Jensen, Schmoll, Hack, & Gwyer, 1993). There was a strong objective paradigm in how the thematic analyses were carried out. For instance, there was an emphasis of making accurate thematic analyses and achieving high inter-rater reliability among the thematic analysers (Fernandes et al., 2015; Gunn et al., 2012; Killins, 2015; McLean et al., 2015) and portray an allegiance to objectivism. Some of the papers expressed a desire for triangulation of quantitative and qualitative data analyses (Fernandes et al., 2015; McLean et al., 2015) and signify how deep and embedded positivism is (Gerrish & Lacey, 2015). Even the only qualitative methodologies that used an interpretivist paradigm of phenomenographic research analysis was still subjected to high inter-rater reliability of the positivism paradigm (McLean et al., 2015).

To summarise, a systematic review of literature from around the world on how anatomy for physiotherapy is taught or learnt has been conducted. Literature on teaching or learning anatomy for physiotherapy around the world is dominated by quantitative methodologies from the positivist paradigm, although there has been a recent interest on qualitative methodologies from the interpretivist paradigm. The allegiance to quantitative methodologies from the positivist paradigm by the physiotherapy profession has handicapped the development of qualitative pedagogical theories for teaching and learning anatomy.

2.3.2 Information-processing cognitive theories used to learn multimedia

Educational psychology has largely shifted from behavioural models to cognitive models over the last century (Morrone & Tarr, 2005). A literature review on information processing cognitive theoretical frameworks for processing multimedia will be fitting because they were the most suitable theoretical frameworks for explaining and analysing the Findings Chapter in the Discussion Chapter (further reasons for choosing the cognitive theoretical frameworks are described in Section 5.1 on page 117). Anatomy is learnt through multimedia intensive ways such as books and electronic resources rich in pictures and imagery (Biasutto et al., 2006; Collett, Kirvell, Nakorn, & McLachlan, 2009; Finn, White, & Abdelbagi, 2011; Tam, Hart, Williams, Heylings, & Leinster, 2009) because the appearance of anatomical structures is central to defining anatomy.

The term multimedia is a relatively modern term and was first used in 1950 in reference to 'multimedia advertising' (Online-Oxford-English-Dictionary, 2016) and has become popular, in part, because of the widespread use of personal computers and their image, graphics and video processing capabilities since the 1980s (Gall, 2004). Mayer provides a multimedia definition widely used among the cognition theories as the use of words (spoken and written) and pictures (illustrations, photographs and video) (Mayer, 2014b). Multimedia learning has been defined in many ways and broadly denotes using multiple formats in teaching and learning in addition to just textual/verbal means (Mayer, 2014b).

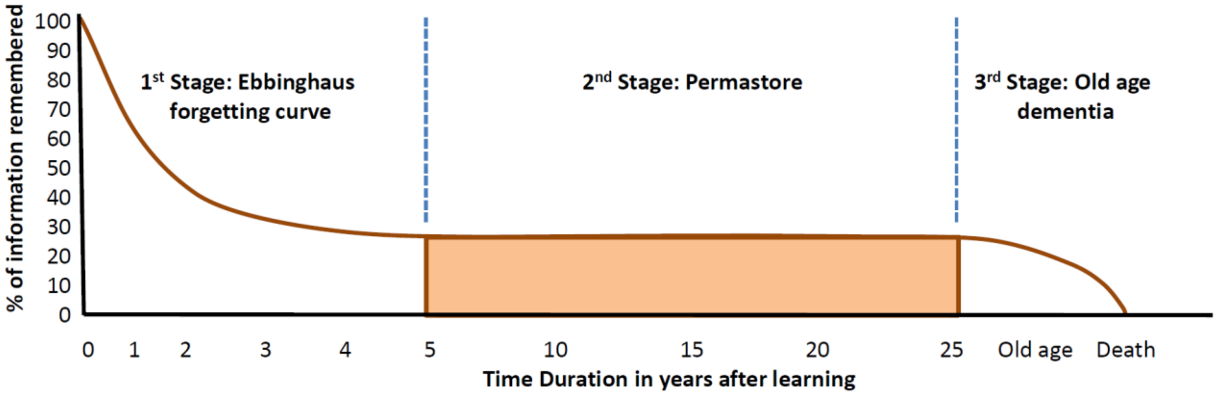
There is a convincing argument that the best instructional design for students has to take into consideration how the human cognitive architecture is arranged, functions and its limitations (Paas & Sweller, 2014). Memory based cognitive theories have been extensively explored on how students learn from multimedia (verbal/text and spatio-visual imagery) and have three main subdivisions that range from the individual psychological level to a curriculum level (Merriënboer & Kester, 2014).

Some of the most influential cognitive theories at an individual psychological level are Paivio's Dual-Coding theory (Clark & Paivio, 1991; Paivio, 1990) and Baddeley's theory of the human working memory (Baddeley, 1992, 1997). The second group of cognitive theories emphasise how multimedia instructional messages could be most effectively designed and some of the most eminent cognitive theories are Sweller's Cognitive-Load theory (Plass, Moreno, & Brünken, 2010a; Sweller, Merriënboer, & Paas, 1998), Mayer's cognitive theory of multimedia learning (Mayer, 2014a) and the Schnotz' integrated model of text and picture comprehension (Schnotz, 2014). The third group of cognitive theories looks at how to most effectively design courses, educational programmes and curricula that have a high proportion of multimedia over a longer period, and the most notable theory is the Four-Component Instructional Design model (4CID model) (Merriënboer, Jelsma, & Paas, 1992; Merriënboer & Kester, 2014; Merriënboer & Kirschner, 2013; Merriënboer, 1997). Psychological theories tend to be built upon earlier theories for some aspect of their underlying assumptions and the assimilated theories will be referred to as 'imports' (Baddeley, 2013). Cognitive theories at a curricular level typically import cognitive theories at a learning or teaching level, which in turn import from cognitive theories at a psychological level.

2.3.2.1 Long-term memory theory of Ebbinghaus

The work in 1885 of Herman Ebbinghaus from Germany is one of the most influential historical papers on the understanding of the long-term memory (Baddeley, Eysenck, & Anderson, 2009; Ebbinghaus, 1913). He measured the rate of how much he forgot fictitious syllables (to avoid contaminating the results with his prior learning) (Ebbinghaus, 1913). He lost information in the long-term memory at the rate that was an inverse exponential decline or negatively accelerating curve, now known as the famous 'Ebbinghaus: curve of forgetting' (Custers, 2010) and is shown in **GRAPH 1** below. The 'Ebbinghaus: curve of forgetting' is characterised by initially large information losses and gradually the losses become smaller in highly controlled laboratory-based experiments (Ebbinghaus, 1913) and has been recently confirmed with minor adjustments (Murre & Dros, 2015). The graph for meaningful information follows the same general shape of the Ebbinghaus curve, but is higher (had less information losses) and is more stretched out in time (information lasts for much longer periods) (Briggs & Reed, 1943; Custers, 2010).

Graph 1: The forgetting timeline in three stages



The X-axis is not to scale.

A different type of research methodology of cross-section naturalistic studies was required to produce two extra extensions to the 'Ebbinghaus: curve of forgetting' and are shown in **GRAPH 1** above (Custers, 2010) and were largely led by Harry Bahrick, an Austrian, who tested the permanence of memories that had not been used for many years (Bahrick & Hall, 1991; Bahrick & Phelphs, 1987; Bahrick, 1984a, 1992). The first part from the naturalistic studies followed the 'Ebbinghaus: curve of forgetting' and was characterised by heavy information losses during the first three to five years (Conway, Cohen, & Stanhope, 1991), five years (Bahrick & Hall, 1991) or five or six years (Bahrick, 1984b) after learning or training without rehearsing. The term 'memory decay' has been used to refer to the loss of anatomical knowledge (D'Eon, 2006; Mateen & D'Eon, 2008) and the loss has been reported to be 26% in 12 months (Blunt & Blizard, 1975) and 60% over four years (Mateen & D'Eon, 2008) among medical students.

There are two major schools of thought on why information in the long-term memory is forgotten. Information is either completely lost or only suffers from difficulty in retrieval, alternatively called the 'seemingly forgotten' stance (Loftus & Loftus, 1980; Norman, 2000). Most hypnotists, counsellors and clinical psychologists are strong believers of the 'seemingly forgotten' view and use intensive interviews to try and extract the seemingly forgotten information (Loftus & Loftus, 1980). However, there is compelling evidence from the 'reconstruction hypothesis' (Bartlett, 1932) that significant and most portions of what we remember are reconstructed memories that differ from past experiences (Loftus & Loftus, 1980).

The second stage following the 'Ebbinghaus: curve of forgetting' had no net loss of information housed in a special memory location called the 'permastore' (Bahrick & Hall, 1991; Bahrick, 1984a, 1984b). The information in the permastore can survive up to eight years (Bahrick & Phelphs, 1987), ten years (Conway et al., 1991), 14 years (Semb, Ellis, & Araujo, 1993), 25 years (Bahrick, Bahrick, & Wittlinger, 1975; Bahrick, 1984b), 5-25 years (Bahrick & Hall, 1991) or 25-30 years (Bahrick, 1984a, 1984b) without rehearsal. The permastore kept knowledge of unrehearsed basic medical sciences for about 50 years after learning (Custers & ten Cate, 2011).

The information in the permastore is tenaciously resistant to forgetting (Bahrick, 1984a, 1984b; Conway et al., 1991; Conway, Cohen, & Stanhope, 1992; Neisser, 1984) and has "immunity against forgetting" (Neisser, 1984) across many different disciplines and types of courses (Custers, 2010). The 'permastore' includes semantic information (Bahrick, 1984b), pictures of faces (Bahrick et al., 1975), names, concepts, conceptual relationships and general and specific facts (Conway et al., 1991). Individuals may have a false perception that the accuracy of information will keep declining when it is actually stable (Conway et al., 1991) because the 'metamemory' of the participants is not always reliable (Custers & ten Cate, 2011). The information in the permastore is thought to be a consequence of sustained rehearsals and relearning (Bahrick, 1984b; Conway et al., 1991), such as spending more years learning (Bahrick, 1984b), passing a critical learning threshold (Neisser, 1984) or having had well-spaced learning (Bahrick, 1992).

The permastore phenomenon is important for teaching anatomy for physiotherapy, not because of the information it holds, but for the cognitive architecture that sustains it. It does not profit physiotherapists or their patients if physiotherapists have 'permastore' knowledge of anatomy they learnt ten years ago during training that they have not used in treating patients. However, it is of immense importance to anatomy teachers to know that their students have cognitive machinery that has 'immunity from forgetting'. The anatomy teachers can then hardwire and engrain the anatomical knowledge into the permastore that will benefit their patients and future professional development. That is why there is no profit in teaching knowledge that will not be used (Cox, 1987).

Forgetting information is highly unlikely if the information is used regularly after formal teaching (Custers, 2010). In essence, repeating, reinforcing and revisiting of information provides most of the "immunity against forgetting" for information in the permastore (Bahrick, 1984b; Conway et al., 1992; Neisser, 1984). In educational practice, it means making re-visitation of information a necessity of formal instruction (Custers, 2010). Spaced learning in an expanding time interval ratio with as much variation as possible and supported by appropriate assessments was advised for creating information that goes into the permastore (Bahrick & Hall, 1991; Custers, 2010).

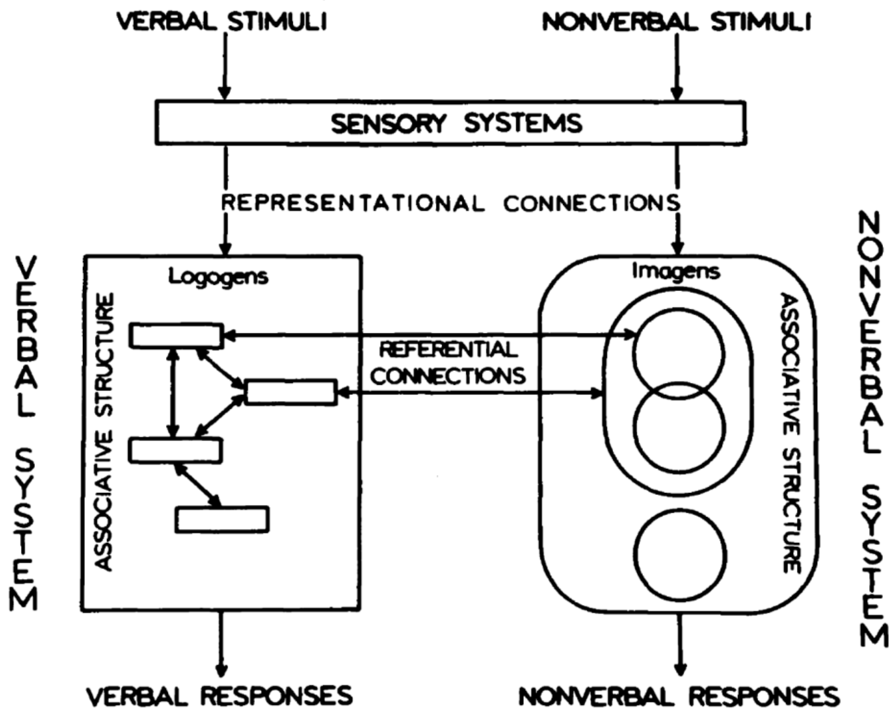
The third stage was age related dementia and had a rapid decline in information reserves (Bahrick & Hall, 1991; Bahrick, 1984a, 1984b), and affects people after the age of 65 years (Conway et al., 1991).

2.3.2.2 Paivio's Dual-Coding theory

Allan Paivio, a Canadian, proposed the influential Dual-Coding theory to explain how information is cognitively processed (Paivio, 1969) and was elaborated in his four major books (Paivio, 1979, 1990, 2013; Sadoski & Paivio, 2013). The Dual-Coding theory is a major cog in a number of cognition and memory theories (Paivio, 1991; Sadoski & Paivio, 2013). In a nutshell, the Dual-Coding theory says that the simultaneous integration of both the verbal and nonverbal mental systems during learning produces more effective learning than just recruiting either the verbal or nonverbal mental channels alone (Paivio, 1979, 1990, 2013). The Dual-Coding theory is also called the Dual-channel theory (Young, Merriënboer, Durning, &

Cate, 2014) or the 'separate-streams hypothesis' (Penney, 1989). The nonverbal mental system, on the left side of FIGURE 2 on page 25, collectively processes non-linguistic mental information, such as pictorial images, environmental sounds (audio that is not processed as words such as a barking dog or ringing school bell), human (motor) actions, haptic (tactile) and visceral sensations from the body (such as taste, smell and emotion) (Clark & Paivio, 1991; Paivio, 1991).

Figure 2: The cognitive architecture of Paivio



The diagram was copied from Paivio, 1990.

The verbal mental system processes linguistic information and visual representations of words (such as printed words), audio recordings of words and verbal feedback of haptic (tactile and motor) activity (Clark & Paivio, 1991; Paivio, 1991). Although the verbal and nonverbal mental systems are functionally independent, they share information through the referential connections and help to describe the nonverbal representations and to 'picture' what is being described (Clark & Paivio, 1991). The 'associative structure' helps the sharing of information within the verbal system (such in using synonyms) or within the nonverbal system by integrating the environmental sounds, human actions, haptic and visceral sensations with the visual images (e.g. the shape that the eyes are seeing with the touch sensation of the object being touched) (Clark & Paivio, 1991).

Words that aroused good mental imagery of the things being taught were called concrete words, while words that are poor at eliciting pictorial imagery were termed abstract words (Clark & Paivio, 1991). Students using concrete words had less hesitations (Reynolds & Paivio, 1968), less confusion and more distinctive meanings (Clark & Paivio, 1989; Paivio, Clark, & Khan, 1988) and students scored higher on comprehension tests (Wharton, 1985) rather than using abstract words. Pictorial imagery aids the learning of textual information (Glenberg & Langston, 1992; Glenberg, Meyer, & Lindem, 1987; Penney, 1989) and makes the reading of text was faster (Glenberg et al., 1987) and the recall of information was more reliable (Paivio & Lambert, 1981; Yuille & Paivio, 1969).

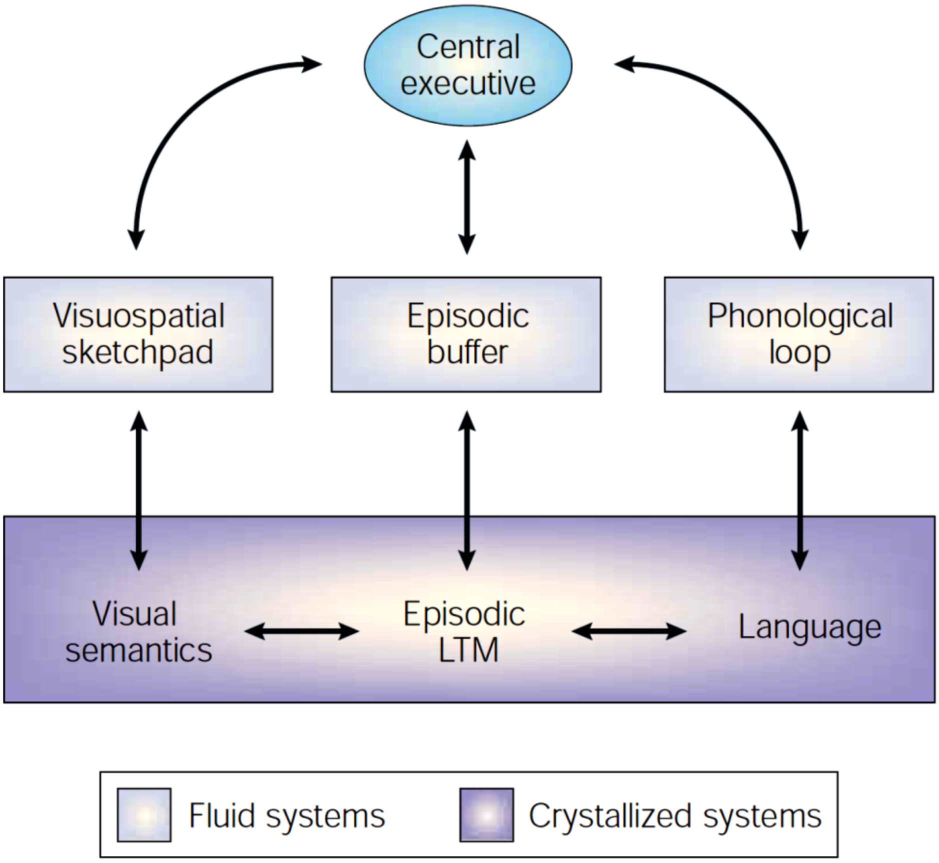
Multiple sensory routes are frequently used in medical education, such as auditory (spoken words in lecture rooms and university hospitals), imagery (pictures of patients with various clinical conditions) and touch (physical examination of patients) (Mayer, 2010). Anatomical teaching is similar because it is taught through talking, rich pictorial imagery in recommended anatomy textbooks, visual-based and haptic-based anatomical dissections and palpations of anatomical structures on patients (Biasutto et al., 2006; Collett et al., 2009; Finn et al., 2011; Tam et al., 2009). The extensive imagery in teaching and learning anatomy justifies considering the Dual-Coding theory and its educational implications.

2.3.2.3 Baddeley's theory of the working memory

Alan Baddeley, who is British, is a leading authority on how the working memory processes information (Baddeley, 2012) and contributed towards the British Postal Code system that people could remember better (Baddeley et al., 2009). The concept of working memory grew from an earlier concept of a unitary temporary short-term memory (R. C. Atkinson & Shiffrin, 1968), which was only for information storage (Baddeley, 1992), and encapsulates the dual roles of information manipulation and storage (Baddeley, 2012). The term 'working memory' was first invented by Miller, Galanter and Pribram (G. Miller, Galanter, & Pribram, 1960) and is characterised by a limited capacity of attention (Baddeley, 2003). The working memory lies at the core of human consciousness (Terrell, 2006).

Baddeley's extensive research work on the working memory persuaded him to propose that the working memory had four components: a central executive, and two subservient slave systems, the visuo-spatial sketchpad (nonverbal system) and the phonological loop (verbal system), and an episodic buffer (Baddeley & Hitch, 1974; Baddeley, 2000, 2003). The relationship among the four components of the working memory is shown in FIGURE 3 on the next page and 'imported' the Dual-Coding theory with separate cognitive streams for verbal (labelled the phonological loop) and non-verbal (labelled the visuospatial) information (Baddeley, 2013).

Figure 3: The cognitive architecture of Baddeley



The diagram has been copied from Baddeley, 2003.

The central executive was postulated to govern the attentional control of the working memory, but held no information storage capacity (Baddeley, 1992, 2000). The central executive integrates information being processed by the visuo-spatial sketchpad, phonological loop and the episodic buffer and brings together their perceived products, like spatial information, colour, tactile (touch) and words, to help make a multimodal meaning (Baddeley, 1992, 2000).

The phonological loop (or articulatory loop) stores temporary phonological information for a few seconds unless if it is rehearsed (Baddeley, 2000) and is the most studied part of the working memory (Baddeley, 1992). The phonological loop finds it harder to process words that sound similar or words with longer word lengths (Baddeley, 2000). The visuo-spatial sketchpad processes information on location, shape and colour, with each feature having its own sub-storage limit (Baddeley, 2003). The memory size of the visuo-spatial sketchpad is related to nonverbal intelligence and is critical for spatially intense careers, such as engineering and architecture (Verstijnen, van Leeuwen, Goldschmidt, Hamel, & Hennessey, 1998), and may have implications for learning three dimensional anatomical imagery. Overloading the visuo-spatial sketchpad with more than four objects may result in ‘change blindness’, where objects can disappear or change colour without people recognising it (Levine & Lewis, 2015; O'Regan, Rensink, & Clark, 1999; D. J. Simons & Levine, 1997). 'Change blindness' serves as a warning that putting too many objects in one image may risk the students not being aware of some of them, like over labelled anatomy diagrams.

The episodic (holds episodes of information) buffer is part of the working memory that is multimodal and its role is to integrate and manipulate information from the long-term memory and the central executive across space and time (Baddeley, 2000). The episodic buffer is under the attentional control of the central executive (Baddeley, 2000).

Baddeley's biggest contribution to cognitive processing of information was the limited processing capacity (Baddeley, 1992, 2003, 2012). The working memory can process two to three complex elements (Sweller, 2004), two to four elements simultaneously (F. Kirschner, Sweller, & Clark, 2006; Merriënboer & Kester, 2014; Paas & Sweller, 2014), three to four verbal chunks like short sentences (Gilchrist, Cowan, & Naveh-Benjamin, 2008), three to five elements in young adults (Cowan, 2001, 2010) or seven plus or minus two elements (G. A. Miller, 1956). The variability among the different papers is because each study used different recall techniques and variable durations after learning, and whether if one or both of the channels of the Dual-Coding theory were recruited. Once the limit is reached for a single channel (Young et al., 2014), the overall processing limits of the working memory can be enhanced by offloading the processing work onto the second channel (Sweller, 1988).

It is poorly understood why the working memory is that small (Baddeley & Hitch, 1974). Some have speculated that a smaller working memory is more efficient for learning because a limit of four creates 24 possible permutations, while a limit of ten potentially creates an unworkable three million permutations (Paas & Sweller, 2014). The processing capacity of the working memory varies across individuals and a larger capacity is associated with better comprehension (Daneman & Carpenter, 1980; Daneman & Merikle, 1996), better ability to follow directions (Engle, Carullo, & Collins, 1991), better logic acquisition (Kyllonen & L. Stephens, 1990) and higher reasoning intelligence (Kyllonen & Christal, 1990). It was Sweller who realised the educational implications of a limited capacity (Sweller & Chandler, 1994) and the contribution will be discussed in the next section.

2.3.2.4 Sweller's Cognitive-Load theory

2.3.2.4.1 Description

The Cognitive-Load theory was put forward by Professor John Sweller (Plass, Moreno, & Brünken, 2010b), an Australian Educational Psychologist, in the late 1980s (Sweller, Ayres, & Kalyuga, 2011; Sweller et al., 1998; Sweller, 1988). The Cognitive-Load theory draws a relationship between psychological constructs of cognitive load and learning, and requires cognitive activities to be streamlined to avoid overloading the limited cognitive machinery of humans, the working memory in particular (Moreno & Park, 2010). Learning strategies that are based on the Cognitive-Load theory require less learning time, less cognitive effort, produce better learning outcomes and performances than other alternatives (Paas, Tuovinen, Tabbers, & van Gerven, 2003). The Cognitive-Load theory has gained a broad appeal and has been successfully used in children (Sweller, 1988), young adults and older adults (Paas, Camp, & Rikers, 2001; van Gerven, Paas, Merriënboer, & Schmidt, 2002). The Cognitive-Load theory has been applied to many different educational disciplines, such as computer programming, physics, mathematics, engineering (Paas et al., 2003) and anatomy (Terrell, 2006). The cognitive load was a much narrower psychological construct when compared to the mental load, and considers fewer characteristics involved in carrying out a task (such as the type of task, how complicated it is, use of multimedia, amount of allocated time and control of instruction) that affect the cognitive load and learning (Moreno & Park, 2010; Paas & Merriënboer, 1994a). The mental load is much broader and considers cognitive, social, physical, environmental and work organisational factors (Moray, 2013).

2.3.2.4.2 Five principles of the Cognitive-Load theory

There are five fundamental principles of the Cognitive-Load theory: the information store principle, schema production and reorganising principle, unlimited working memory in expert learners' principle, problem solving principle and the narrow limits of change principle.

The first principle assumes that the long-term memory can store an infinite (Young et al., 2014), near infinite (Paas et al., 2003; Simon & Gilmartin, 1973) or a very large (Paas & Sweller, 2014) store of information, as indicated in FIGURE 4 on the next page.

Figure 4: The cognitive architecture of the Cognitive-Load theory

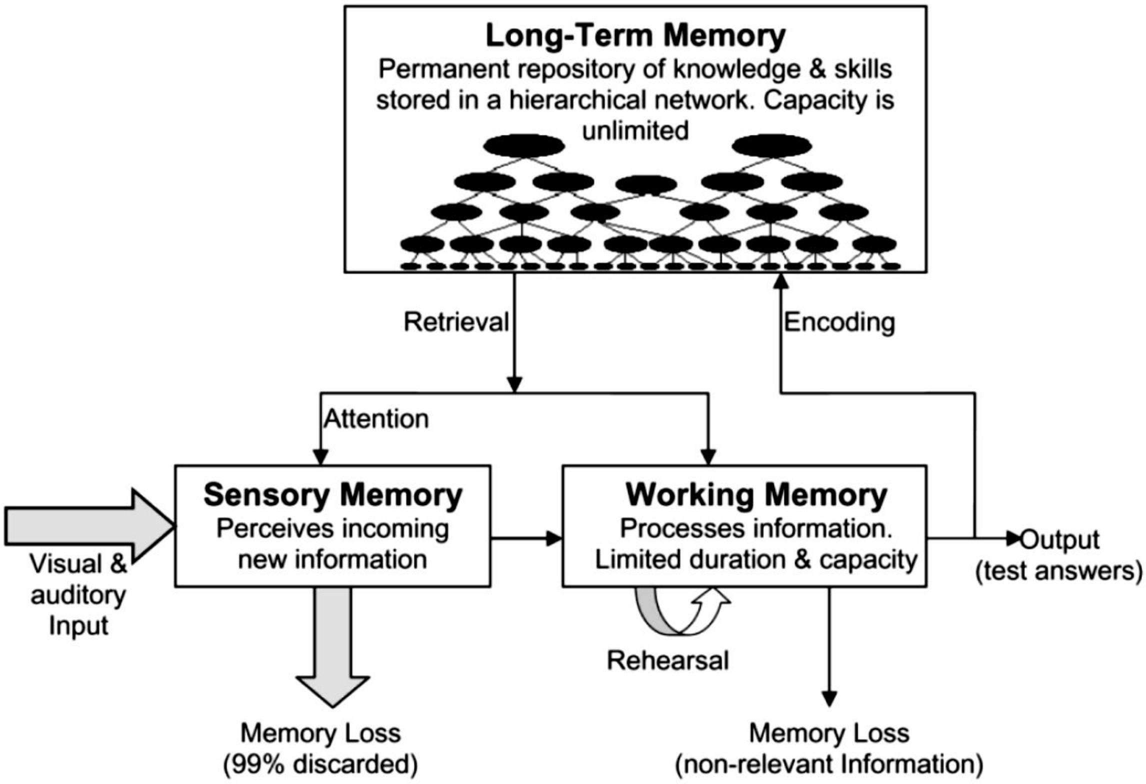


Figure 1. The cognitive architecture of the human memory system based on information processing theory.

The diagram has been copied from Terrell, 2006.

The extremely large long-term memory mostly arose from the observations of chess grandmasters that could memorise up to 100 000 (Chase & Simon, 1973; Simon & Gilmartin, 1973) or over 100 000 (Amidzic et al., 2001) chess board permutations. Moreover, the information in the long-term memory is said to last forever (Paas & Sweller, 2014; Young et al., 2014).

The second principle of producing and chunking schema and third principle of unlimited working memory in expert learners are intertwined. According to the much older schema theory proposed by Sir Frederic Charles Bartlett (Bartlett, 1932) that has stood scientific scrutiny, knowledge in the long-term memory is kept as a network of lower order units (facts) and higher order units, and their relationships (Sweller, 1994), although some scholars exclude the lower order information (Schnotz & Kürschner, 2007). Schemata information allows new information to be added or modified (Moreno & Park, 2010; Sweller, 1994) for retrieval of information when requested or needed (Sweller, 1994) and provides a 'route map' of how to retrieve information for recall (Young et al., 2014). Learning based on the Cognitive-Load theory is defined as cognition that results in either schema acquisition, modification or chunking and can either be controlled or automated (F. Kirschner et al., 2006; Paas & Sweller, 2014).

Many information elements can be effectively summarised into one element in a process called ‘chunking’ (G. A. Miller, 1956). The ‘chunks’ are still called ‘schema’ (Sweller, 1994). The chunking process produces greater schema sophistication, recognition of more complex patterns and more concise schema that enables greater and faster automation of schema in huge quantities (Merriënboer & Kester, 2014; Paas & Sweller, 2014; Plass et al., 2010a).

Controlled use of the schemata is slow, requires significant attentional effort and is a characteristic of novice learners (Schneider & Chein, 2003; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1984). Novice learners have a working memory with a limited processing capacity of usually four elements simultaneously (Cowan, 2001, 2010), and of limited duration of up to 20 seconds (Peterson & Peterson, 1959), 5-20 seconds (Terrell, 2006) or less than 30 seconds (Mayer, 2010). In contrast, automation of schemata occurs in expert learners when information in the long-term memory is seamlessly and subconsciously used in the working memory, without placing any cognitive demands on the working memory in the process (Schneider & Chein, 2003; Shiffrin & Schneider, 1984) and is the hallmark for successful learning (Sweller, 1994). The automation of chunked schemas, usually developed through extensive practice, makes problem solving much more rapid, easier and more effortless (Birnboim, 2003; Kotovsky, Hayes, & Simon, 1985; Schneider & Chein, 2003; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977), e.g. in geometry problems (Koedinger & Anderson, 1990) and word-based problems (Low & Over, 1990). Chunking and automation has been demonstrated in experts (Moreno & Park, 2010; Plass et al., 2010a) of chess (Chase & Simon, 1973), electronics (Egan & Schwartz, 1979) and algebra (Sweller & Cooper, 1985).

The fourth principle discourages the use of solving unfamiliar problems as a learning strategy (Plass et al., 2010a), although they stimulate creativity (Sweller, 2009), because students apply solutions by chance (Plass et al., 2010a) and produce many more dead-ends than satisfactory responses (Sweller, 1988). Allowing the students to study worked examples in the earlier stages produced better attainment levels than asking the students to solve similar unworked problems themselves (Renkl, 2014). The Cognitive-Load theory prefers to give the students the strategies that will help the students to solve problems rather than letting the students spend lots of time trying to discover the problem solving strategies that can help them to solve problems (Plass et al., 2010a). The fifth principle relates to the long-term memory being geared for small changes because larger changes compromise the integrity of a larger proportion of the information in the long-term memory (Paas & Sweller, 2014; Plass et al., 2010a). The limited working memory works as a gatekeeper and limits how much information is processed and learnt (Plass et al., 2010a). The implications for teachers are that only a small amount of knowledge can be learnt during a teaching session.

2.3.2.4.3 *Types of Cognitive Loads*

2.3.2.4.3.1 *Extraneous Cognitive Load*

The extraneous cognitive load, the first of the three cognitive loads to be described (Chandler & Sweller, 1991; Moreno & Park, 2010), is caused by preoccupying the working memory with irrelevant elements (Plass et al., 2010a). Learning spread across multiple sources (split-attention principle) (Ayres & Sweller, 2005) increases the extraneous cognitive load because students are exposed to significant amount of redundant information (Kalyuga & Sweller, 2014).

2.3.2.4.3.2 *Intrinsic Cognitive Load*

The intrinsic cognitive load, the second cognitive load to be described (Moreno & Park, 2010; Sweller, 1993), is governed by the inherent difficulty of material to be learnt (Plass et al., 2010a) because some problems or educational tasks are intrinsically more difficult to resolve than others (Moreno & Park, 2010). The intrinsic cognition load of a task should not exceed the processing capacity of the working memory of usually four different elements simultaneously (Cowan, 2001, 2010)

Element interactivity was the first concept found to increase the intrinsic cognitive load (Sweller & Chandler, 1994) and problems with increased interactivity were harder to solve for children (Halford, Maybery, & Bain, 1986; Maybery, Bain, & Halford, 1986). Element interactivity refers to the number of elements that must be processed simultaneously in the working memory (Moreno & Park, 2010; Plass et al., 2010a). The capacity of the working memory drops to between two and three elements (Sweller, 2004) or between two and four different elements when more complex elements have to be processed simultaneously (F. Kirschner et al., 2006; Merriënboer & Kester, 2014; Paas & Sweller, 2014). In disparity, about five to nine elements can be processed if they are simple (G. A. Miller, 1956). Understanding is where the solution can be generated from the simultaneous processing of all the elements in the working memory (Paas & Sweller, 2014; Sweller et al., 1998).

The intrinsic load can be reduced by practising chunking techniques and automation of chunked schema (Moreno & Park, 2010; Young et al., 2014) or using instructional sequencing that starts with simpler material and gradually moves towards more complicated material (Gerjets, Scheiter, & Catrambone, 2004; Merriënboer, Kirschner, & Kester, 2003). The element interactivity can also be reduced by teaching isolating content before unified learning material (Ayres, 2006; Pollock, Chandler, & Sweller, 2002) or the teacher directing the attention of students on one facet of the complexity at a time (Merriënboer, Kester, & Paas, 2006). It should be warned that both insufficient or excessive intrinsic loads are detrimental to learning (Gerjets et al., 2004; Moreno & Park, 2010).

One of the problems with the intrinsic is that some educational tasks are more difficult than others, despite having the same number of elements and element interactivity (Klahr & Robinson, 1981). For example, inverse relationships are much harder to learn and require higher intrinsic loads than directly proportional relationships (Campbell, 1988). The precise interactivity thresholds that overwhelm the working memory are still not clear (Moreno & Park, 2010), even though the factors that increase the interactivity have been described (Sweller & Chandler, 1994).

2.3.2.4.3.3 Germane Cognitive Load

The germane cognitive load, the last cognitive load considered (Moreno & Park, 2010; Sweller, 1988), aims to make future cognition easier and more efficient (Schnotz & Kürschner, 2007), in contrast to the intrinsic cognitive load which aids the understanding and solving of problems (Sweller, 1993). The germane load is raised when the working memory is intentionally applying learning tactics, seeking patterns, reorganising problems in order to best solve them, supervising metacognition cognition and learning, and reflecting on learning (Schnotz & Kürschner, 2007). The germane cognitive load involves abstracting, handling, constructing and automating of schemas (Moreno & Park, 2010; Schnotz & Kürschner, 2007). The modification of schema for strategising can be fostered by using certain instructional techniques (Jong, 2009) that encourage the comparing, distinguishing, arranging, interpreting, exemplifying, categorising and deducing of information (Mayer, 2002).

The germane load is limited by the processing capacity of the working memory and the size of the intrinsic and extraneous loads (because they both draw from the same working memory) (Schnotz & Kürschner, 2007). More motivated learners have higher germane loads than less motivated students (Renninger, Hidi, & Krapp, 2015). The combined germane and intrinsic loads should both be maximised within the limits of the working memory, while the extraneous load should be minimised as much as possible, since all the three cognitive loads have an additive effect on the processing capacity of the working memory (Moreno & Park, 2010; Plass et al., 2010a).

Good educational practice should promote schema construction and automation that increases the germane load (Sweller et al., 1998). High variability in the instructional methods is associated with the higher germane loads and produces better transfer learning and encourages schema production (De Croock, Merriënboer, & Paas, 1998; Sweller et al., 1998). The 'transfer' term in psychology refers to the ability to apply what has been learnt in one context into other contexts (Norman, 2000).

Researching on the germane load can be ambiguous because what is classified as the germane load is only done so after successful learning and not before, a sort of 'post-hoc' parameter (Jong, 2009; Schnotz & Kürschner, 2007), where the germane load is only present if there is an intrinsic load. The germane load ought to be defined before the evaluation of the effects on learning to properly appraise the empirical effects on learning and not assume that the germane load always helps learning (Schnotz & Kürschner, 2007). With learning, some have argued that if the intrinsic load and the germane load exceed the working memory, the excess germane load ought to be called the extraneous load (Jong, 2009), and blurs the difference between the germane load and the extraneous load.

2.3.2.4.4 Criticisms

The Cognitive-Load theory ignores several factors that affect the learning of an individual, such as the impact of values, expectations, goals (Bannert, 2002), cognitive prowess, motivation, self-regulation (Moreno, 2005), affective (Bannert, 2006; P. A. Kirschner, Ayres, & Chandler, 2011), task engagement and perception (Plass et al., 2010b). While it may not be necessary for the Cognitive-Load theory scholars to justify the basis of the theory 'imports' used in Cognitive-Load theory, it is essential and imperative for Cognitive-Load theory's own new assumptions to be verified (Gerjets, Scheiter, & Cierniak, 2009). Other scholars feel that all the assumptions used by the Cognitive-Load theory ought to be scrutinised (Plass et al., 2010b). Is extraneous cognitive load really harmful for effective learning? (Gerjets et al., 2009). For example, the additive nature of the three cognitive loads have not been empirically determined and the ability to separate them from each other completely has been questioned (Gerjets et al., 2009; Plass et al., 2010b). The separate verbal processing and nonverbal processing systems of (Paivio, 1990) and (Baddeley, 2000, 2003) have not yet been factored into the additivity hypothesis of the extraneous, intrinsic and germane cognitive loads (Plass et al., 2010b). Comparing, rearranging and interpreting information can be used by all the three cognitive loads, but producing different cognitive outcomes: producing confusion, no learning or change in the schema for the extraneous load, producing learning and understanding for the intrinsic load and producing future problem solving strategies for the germane load. However, testing the integrity assumptions of Cognitive-Load theory will be very difficult to carry out because the assumptions are not objective (Brunken, Plass, & Leutner, 2003; Schnotz & Kürschner, 2007).

Most studies do not measure the cognition load directly (Schnotz & Kürschner, 2007) because there are no reputable, reliable and valid measures for the extraneous, intrinsic and germane loads. Indirect and crude measuring techniques to measure the cognitive load have been used, such as subjective rating scales (Paas & Merriënboer, 1994b), physiological (such as heart rate changes to denote when the working memory capacity has been reached) (Mulder, 1992)) and decreases in task performances when the working memory reaches its limits (Brunken et al., 2003). There are no assessment tools available to predict cognition loads either (Paas et al., 2003). The lack of objectivity is hampering the research into their educational implications (Moreno & Park, 2010; Plass et al., 2010b; Schnotz & Kürschner, 2007).

Many have questioned whether the predictions based on findings of the Cognitive-Load theory researched from highly controlled experiments (Plass et al., 2010b; Schnotz & Kürschner, 2007) are really applicable to real life scenarios (Jong, 2009; Plass et al., 2010b), have any long-term learning effects (Plass et al., 2010b) or can be generalised and applied beyond of mathematics, science and technical areas where the empirical research was done (Plass et al., 2010b). It is not clear if successful learning entails less cognitive effort, quicker learning, deeper learning or more interesting learning (Plass et al., 2010b). Despite the above criticisms, the Cognitive-Load theory remains the most prominent theory on instructional design (Gerjets et al., 2009), has influenced many teaching practitioners (Schnotz & Kürschner, 2007) and is the most dominant theoretical framework in educational psychology (Plass et al., 2010b).

2.3.2.5 The Four-component instructional design model

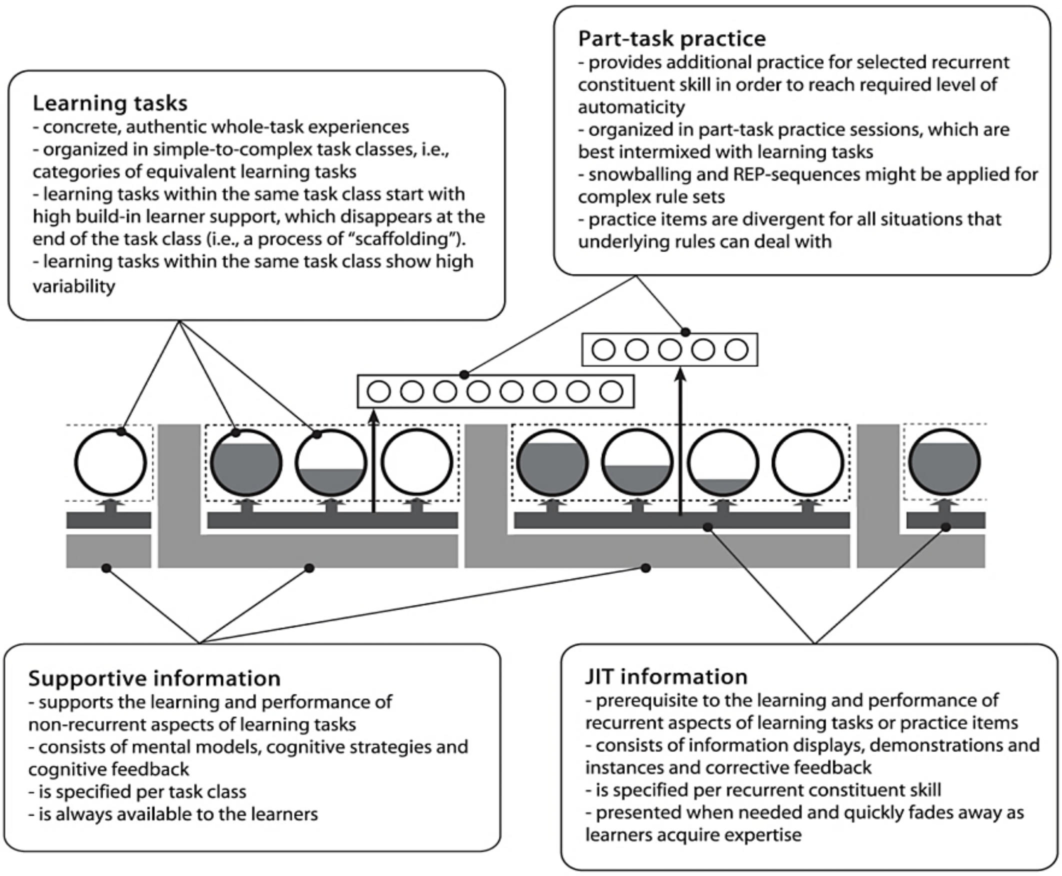
Jeroen van Merriënboer, an international expert on education for health professions from the Netherlands, invented the only multimedia cognitive theory at a curricular level called the Four-component instructional design model (4CID model) (Merriënboer et al., 1992; Merriënboer & Kirschner, 2013) .

The 4CID theory drew from the Dual-Coding theory of Paivio (Merriënboer & Kester, 2014), although the name of Paivio was not expressly mentioned. The 4CID theory also ‘imported’ the work of Baddeley on the limited working memory (Baddeley, 1992, 1997) and Sweller’s Cognition-Load theory and its assumptions on cognitive architecture (Merriënboer & Kester, 2014). The ‘importation’ of the Cognition-Load theory is understandable given that Merriënboer visited the lead scholars of the Cognitive-Load theory (Sweller et al., 2011) during his sabbatical year in Australia (Merriënboer & Kirschner, 2013).

The 4CID theory was born out of the limitations of the existing cognitive theories. The 4CID model is said to be better suited for understanding complex learning, enhances the amalgamation of knowledge, skills and attitudes, and better links them to everyday life or professional work situations by using realistic or simulated learning tasks (Merriënboer & Kester, 2014). Some teachers attempt to break complex learning into simpler cases, but students find it harder to learn the intricate relationships between the components or use the fragmented knowledge (Merriënboer & Kester, 2014). The 4CID theory hopes to teach the complexity and underlying relationships between many specialist areas (Merriënboer & Kester, 2014). While most instructional approaches focus on either cognitive, affective or psychomotor spheres, the 4CID model tried to bring these spheres together (Merriënboer & Kester, 2014).

The 4CID model has four central pillars: realistic learning tasks, supportive information, procedural information (also called the Just-In-Time information) and part-task practice (Merriënboer & Kirschner, 2013; Merriënboer, 1997), as shown in FIGURE 5 below.

Figure 5: The four components of the 4CID theory



The diagram has been copied from Merriënboer, Clark, & De Croock, 2002.

The students are given authentic learning tasks and experiences that mimic real life problems, as close as possible to those they would face upon graduation (Merriënboer & Kester, 2014). Real life situations are usually ill-defined (hard to fully describe), use multiple domains, have equivocal solutions and even incomplete information (Merriënboer & Kirschner, 2013). The main aim of the learning tasks is to stimulate and develop schemata from the concrete experiences through inductive reasoning (Merriënboer & Kirschner, 2013) that can then be applied to future scenarios (Merriënboer & Kester, 2014). Although real life environments are mostly preferred, simulated environments can be used alternatively if real-life environments are too expensive, logistically difficult or unsafe for patients (Merriënboer & Kirschner, 2013) and are highly praised in earlier learning phases (Merriënboer & Kirschner, 2013).

Part-task practice provides additional opportunities to practice the routine learning tasks and reach excellent levels of automaticity (Merriënboer & Kester, 2014). The 4CID theory encourages schema automation by using certain schema so frequently and efficiently that the working memory is hardly taxed and is freed up to do other cognitive processing (Merriënboer & Kester, 2014).

Supportive information is information that is usually not the solution to questions, but information that helps students strategically approach similar generic problems (Merriënboer & Kester, 2014) and comes in the form of the teacher providing guidance and scaffolding (Merriënboer & Kirschner, 2013). The term 'scaffolding' rose to prominence in the 1970s and explains the directing of things that are beyond the control of the learner and assists the learner complete their learning tasks (Greenfield, Maynard, & Childs, 2003; Rosenshine & Meister, 1992). In practice, scaffolding guides the learners through thinking aloud, giving guiding questions, constraining the learning and giving the student similar solved problems (Merriënboer & Kirschner, 2013). The scaffolding help from the teacher has to gradually fade, timewise and in intensity, as the learner builds schemata that help the learner to autonomously undertake the learning tasks (Merriënboer & Kirschner, 2013). Procedural information, provides the sequential steps that one has to go through to perform routine authentic learning tasks and examples include 'how-to-instructions' and corrective feedback (Merriënboer & Kirschner, 2013; Merriënboer, 1997).

The 4CID theory has a number of limitations, such as being poor at contributing to the human cognitive architecture at a psychological level (Merriënboer & Kester, 2014). The precise educational fields where the 4CID could be applied have not yet been delineated (Merriënboer & Kester, 2014). Many other variables can influence the success of using the 4CID theory, such as financial constraints (to get the required equipment, human resources, learning infrastructure and time) and the characteristics of the students (e.g. computer literacy, sizes of the class etc.). However, despite the weaknesses, the 4CID is helpful in that it moves the cognitive theories towards real-life situations in higher educational settings that use a whole task methodology (Merriënboer & Kester, 2014).

2.4 The knowledge void to be addressed

There is a scarcity of qualitative literature offering pedagogical guidance on teaching anatomy for physiotherapy in the UK, despite the widening scope of physiotherapy and more physiotherapists entering the profession (Bithell, 2007; CSP-Scope, 2008). This thesis hopes to partially fill that literature gap.

2.4.1 Research Aim

The aim of the study is to propose a new pedagogical theory based on a qualitative methodology that could characterise and explain the current and preferred dominant pedagogical concepts used by anatomy teachers who are physiotherapists, to promote the long term learning of anatomy by physiotherapy students in the UK.

2.4.2 The research objectives of the study

The research objectives of the study are to find out the:

1) Main pedagogical concepts used for teaching and learning anatomy for physiotherapy
2) Which of the main pedagogical concepts were used for influencing the use of teaching resources, such as the quality and number of teaching, technical and administrative staff, learning resources, time resources and use of buildings
3) Which of the main pedagogical concepts were used for influencing the planning, delivery, assessment and evaluation of teaching and learning anatomy for physiotherapy
4) The relationships between the main pedagogical concepts used for teaching and learning anatomy for physiotherapy
5) The long-term standards (five years after graduation) that anatomy teachers for physiotherapy use for judging the effectiveness of their teaching of anatomy during the professional physiotherapy practice of their graduates

2.5 Conclusion of the Literature Review

The physiotherapy profession in the UK is about a 125 years old (Barclay, 1994). The profession has grown from being an optional unproven healthcare appendage to being an essential part of mainstream healthcare (Frantz, 2007) and is currently part of the publicly funded NHS (Barclay, 1994; Wright, 2007). Anatomical knowledge and skills are highly essential for training physiotherapists (Latman & Lanier, 2001; Mattingly & Barnes, 1994) and have a long history with training of British physiotherapists (Barclay, 1994), but teaching interest and scholarship in the UK has waned in the last few decades. The review of literature exposed a scarcity of guidance, especially based on qualitative pedagogical theoretical frameworks, for the UK context on how anatomy for physiotherapy could be most effectively taught and learnt. A literature review of theoretical frameworks on cognition (like the Ebbinghaus' theory on the long-term memory, Dual-Coding theory, working memory theory and the Cognitive-Load theory) was described and will be used to explain the Findings Chapter in the Discussion Chapter. A list of research objectives has been drawn up to help guide the research design that will generate a pedagogical theory that could explain how anatomy for physiotherapy could be more effectively taught and learnt. The following Research Design Chapter will discuss a research design that answers the research objectives.

3 Research Design Chapter

3.1 Introduction to the Research design

The research design for this thesis was a grounded theory methodology which analysed transcripts of interviews with anatomy teachers for physiotherapy describing the dominant pedagogical concepts they used to teach to physiotherapy students in the UK.

The ontology, epistemology, methodology and methods were carefully considered for this study in an earlier module (in APPENDIX 28 from page 264) and the Research Proposal (from APPENDIX 31 from page 359), and includes the current chapter what actually transpired from the proposed research plans. The following section presents a briefer and summarised view, in the hope of illuminating to the reader of this thesis the contribution of the earlier modules. The chosen ontology, epistemology, methodology and methods were nominalism, radical constructivism, grounded theory and interviews, respectively, and were critically examined in that respective sequence in what is widely known as a research 'onion' approach (Saunders, Lewis, & Thornhill, 2009). The chosen ontology, epistemology, methodology and methods played significant roles of regulating the choice of subjects, the practical methods used and how the results of this study were analysed (Hesse-Biber & Leavy, 2005; Hitchcock & Hughes, 1995).

3.2 Deliberations on the appropriate ontology, epistemology and methodology

3.2.1 Choice of ontology and epistemology

Ontology is the study of being, existence or "nature of reality … (or) things", p.21 (Hitchcock & Hughes, 1995). Burrel and Morgan's dualism theory of ontology, a widely respected and popular ontological theory, was adopted by this study and views existence through nominalism (names and labels made by minds) or realism (tangible things) (Burrell & Morgan, 1979; Cohen, Manion, & Morrison, 2007). The current study wants to find 'pedagogical concepts' and they would be on the nominalism end of the dualism theory of ontology (Hitchcock & Hughes, 1995). An evaluation of how we can 'know' of these 'concepts' was made by choosing an appropriate epistemology.

The word epistemology is derived from the Greek words 'logos' (the study of) and 'episteme' (knowledge or understanding) and is a philosophical branch that deals with how we come to know of things in existence (Feder, 2013). Each epistemological theory has a set of assumptions and validity threshold for defining what counts as knowledge (Hitchcock &

Hughes, 1995; D. Scott & Usher, 1999) that have to be respected throughout a research study. Radical constructivism was the chosen epistemology for this study. Radical constructivism, invented by the late Professor Ernst von Glasersfeld, is one of the most well-known among the various types of constructivist theories (Olssen, 1996; Suchting, 1992) and is on the personal end of the personal-social spectrum in the field of constructivism (Olssen, 1996). Radical constructivism says that knowledge is created when an individual uses their past experiences to create new rules that make sense or interpret their current environment (Glasersfeld, 1990, 2001). There were several reasons for choosing radical constructivism. The physiotherapy profession did not exist over a hundred years ago and it was cognitively created or constructed over the last hundred years. Radical constructivism is already the dominant epistemology in teaching science in the USA (Ernest, 1993; Gruender & Tobin, 1991; Novak, 1988) and can easily be extended to physiotherapy. The teaching of anatomy for physiotherapy is "highly variable" in the USA, p.3 (Reimer et al., 2013) and in Japan (Kawashiro et al., 2009) and suggests that individualistic driven pedagogical concepts of anatomy teachers are dominating and is compatible with radical constructivism that extols individual knowledge creation (Glasersfeld, 1990).

Radical constructivism is a subjective and interpretive type of epistemology, which does not allow transfers of knowledge between individuals, unlike positivism (Neuman, 2005; Sarantakos, 2005) and has a bearing on how the researcher acquires knowledge from the participant or how the reader of this thesis acquires knowledge from this thesis. Knowledge was or will be constructed at three stages in the current study. The first stage of creating knowledge occurred when an anatomy teacher for physiotherapy (participant) created/constructed knowledge of pedagogical concepts by creating rules that best explained situations in their experiences of teaching anatomy to physiotherapy students. The second stage of constructing knowledge was when I was interpreting and analysing what an anatomy teacher for physiotherapy was saying during the interviews about teaching anatomy from their educational context. My past anatomy, physiotherapy and teaching experiences played a significant role in the interpretation and construction of knowledge during the second stage, but there are dangers that my own preferred ideas may dominate the interpretation and construction of knowledge. Section **3.5.4** on page **61** deals with some of the safe guards I made to limit the dangers. The third stage of constructing knowledge is where the reader of this thesis is interpreting and making sense of this thesis book. I have tried to make the interpretations easier by making the thesis logically sequenced, including many explanatory diagrams and tables and explaining technical anatomy and physiotherapy terms as much as possible throughout the thesis.

3.2.2 Choice of methodology

The methodology refers to a strategy or theoretical framework that is compatible with the chosen ontology and epistemology and guides the methods of the study (Hesse-Biber & Leavy, 2005; Sarantakos, 2005), where methods will be defined as the practical ways of collecting research evidence (Carter & Little, 2007). The terms ‘methodology’ and ‘methods’ are frequently used wrongly and/or synonymously by academics (Gorman, 2011).

A methodology was sought that could create a pedagogical theory from nominal concepts of how to teach and learn anatomy for physiotherapy that could help other anatomy teachers for physiotherapy. Grounded theory theoretical framework invented by Glaser and Strauss was found to be the most appropriate and typically involves analysing interview transcripts (Glaser & Strauss, 2006). Grounded theory was chosen because it mandatorily allows conceptual ideas and their relationships to arise from participants to converge into a theory, rather than just analyse descriptions, an intended objective of the current study, while it is optional for other methodologies (Gerrish & Lacey, 2015). Grounded theory is said to be appropriate for studies wishing to explore interactions between people and things, and was an intended objective of the current study (Gerrish & Lacey, 2015). Intensive interviews are the mainstay of the grounded theory methodology because they promote dialogue for concepts to arise and to be followed-up immediately, and allow for real-time clarifications of potential mis-interpretations by the interviewer (Charmaz, 2014; Glaser & Strauss, 2006; Glaser, 1998).

Grounded theory is thought to be epistemologically neutral enough (Glaser & Strauss, 2006; Glaser, 2002) to be used with any other epistemology (Annells, 1996, 1997; Mills, Bonner, & Francis, 2006). Kathy Charmaz, a former student of Glaser and Strauss, tweaked the original grounded theory methodology to suit constructivism and is a leading authority on constructivist grounded theory (Charmaz, 2014). Her major contribution to constructivist grounded theory was the idea of ‘double construction’, where the researcher executes a second construction of knowledge during a research interview on the knowledge that the interviewee would have created before coming to the interview (Charmaz, 2014), and has been supported by others (Mills et al., 2006). Double construction is traditionally referred to as analysis of research results (Charmaz, 2014). The coming sections on the ‘Procedures’ (in Section 3.4) and ‘Analysis of interview data’ (in Section 3.5) describe the practical methods used in the study that are congruent with an ontology of nominalism, epistemology of radical constructivism and methodology of grounded theory.

3.2.3 Inappropriate methodologies considered

The chosen ontology of a study ought to inform the chosen epistemology, which in turn governs the choice of methodology (Sarantakos, 2005). The central defence line for excluding case study, phenomenology, the Delphi and ethnography methodologies will be based on not or inadequately supporting the nominal ontology of pedagogical thoughts and the epistemology of radical constructivism.

3.2.3.1 Case study

The methodology of case studies is recommended for examining “a specific (or) complex functioning thing” (p.2) (Stake, 1995), which could be a single social entity or phenomenon occurring in a room, building or institution, such as a person, classroom or system (H. Simons, 2009). Case studies are favoured if the knowledge of the contextual background case is essential for better understanding a phenomenon (Yin, 2013). Single case studies typically use many sources of data (Baxter & Jack, 2008) and are well known for triangulating various sources of data from many investigators using different theories and methods (Tellis, 1997). Triangulation of data in case studies is thought to promote better objective accuracy, validity (Stake, 1995; Yin, 2013) and credibility (Patton, 1990; Yin, 2013), but is hard to reconcile with the current study requiring an epistemology based on an interpretivist paradigm and subjective knowledge (Glasersfeld, 1990).

A single case study is allowed to contain many conflicting epistemologies or research designs (Corcoran, Walker, & Wals, 2004) and has been associated with being called a ‘catch-all’ research category for research designs that do not fit a survey or experiment (Merriam, 1998). Although case studies can research nominal ontologies, such as concepts (Gerrish & Lacey, 2015), case studies are seen as a way of jellying together separate autonomous streams of data with their own separate positivist or interpretivist approaches (Vennesson, 2008). It is common for case studies to be too flexible in the type of data collected and they may suddenly include data that looks interesting or that is newly discovered during the data collection, but would then deviate from the research objectives or ontology to be accepted (Yin, 2013). Most users of the case studies have a shallow understanding of the theoretical limitations and the theoretical rigour (e.g. of the ontology and epistemology) of the case study methodology (Corcoran et al., 2004). A good example of a case study that involves teaching anatomy to physiotherapy students with no specific experiential design and an admittedly weak scientific rigour is by Noonan and her colleagues (Noonan et al., 2012).

On the whole, it is hard to justify case studies to off-the shelf theoretical frameworks (Vennesson, 2008). Case studies typically use multiple lenses (Baxter & Jack, 2008), like various ontological and epistemological theoretical lenses in the same case study, while the current study requires a specific nominal ontological theory and matching epistemological theory. Data for case studies comes from not only what the main actors think and say, but also from how they interact with other groups (Tellis, 1997) and is not a good fit for the current study because the main focus is on the thoughts of the main actors. A case study was not appropriate because it usually focuses on "a (social) system of action" (p.2) rather than a person or a group of people (Tellis, 1997), while the current study requires a focus on the thoughts that a group of anatomy teachers had.

3.2.3.2 Phenomenology

Phenomenology is a methodology designed for exploring how people experience events or phenomenon from the participants' subjective point of view in what is referred to as the 'lived experience' (Gerrish & Lacey, 2015). The focus could either be describing the experiences or interpreting their experiences (Finlay, 1999). Phenomenology has a stronger inclination for describing the lived experience than for developing causal explanations and a theory (Finlay, 1999), which was the intention of the current study. Phenomenology would have shifted the main focus from highly effective concepts to the experiences of teachers. Adopting the phenomenology methodology would have significantly changed the research question from generating the effective and dominant pedagogical concepts used by anatomy teachers of physiotherapy to how the anatomy teachers interpreted their lived teaching experiences.

3.2.3.3 The Delphi methodology

The Delphi methodology is better suited for the gaining consensus on a set of points by a panel of experts through a succession of intensive questionnaires (Gerrish & Lacey, 2015) until when group consensus is achieved (Hasson, Keeney, & McKenna, 2000). Group opinion has more gravitas than opinions of individuals because it is said to be more valid and reliable (Gerrish & Lacey, 2015). The Delphi methodology is poor at describing the relationships between the points or explaining complex phenomenon, which is at the heart of the research objectives of the current thesis. The Delphi methodology usually needs a substantial starting list and literature could be used to generate the initial questionnaire (Hasson et al., 2000), but the insufficient British literature would have made the task difficult. Showing participants a substantial starting list could bias the participants. The Delphi methodology poorly accommodates the complexity of information and highly curtails the ability to pose richer probing questions that can better explore information from participants.

3.2.3.4 Ethnography

Ethnography is about examining the perceptions, behaviours, feelings and interactions of members of a social or cultural group or community, in their local environment usually by having a researcher embedded or immersed in that community (Gerrish & Lacey, 2015; Reeves, Kuper, & Hodges, 2008; Roper & Shapira, 2000). The Greek word for "ethno" describes a culture/people and "graphy" is about writing (Gerrish & Lacey, 2015). The focus is primarily on learning from people (Roper & Shapira, 2000) through observing behaviours and asking questions (Gerrish & Lacey, 2015) as a primary ontology rather that the concepts they hold. Ethnography has a much weaker allegiance to theoretical frameworks, such as ontology and epistemology, and frequently the research relies on convenient informal and casual data collection methods (Reeves et al., 2008) and jeopardises the research design rigour and defensibility. An ethnographic study would not have followed a nominal ontology and an epistemology of radical contructivism. Ethnographic studies typically use data triangulation (Reeves et al., 2008), which is associated with unclear ontological and epistemological inclinations. The concepts held by the minds of participants may differ from what may be observed from viewing teachers teaching. Furthermore, I did not have enough time to be fully embedded into the teaching communities of the participants for extended periods of time because ethnography is based on the researcher having first-hand experience in the 'natural setting' (Gerrish & Lacey, 2015).

3.3 Participants

Qualified physiotherapists teaching anatomy modules were chosen as participants, rather than any other groups of people, because they would have had the most amounts of physiotherapy and anatomy teaching experiences that could have fostered the creation/construction of cognitive rules (based on radical constructivism) of what are the most effective ways of teaching and learning anatomy and physiotherapy. They would have tested, reviewed and modified their own pedagogical cognitive rules. The expected participants had to be physiotherapists for them to be able to see and understand how the anatomical knowledge will be used in the clinical settings.

The age of integrated teaching requires anatomy teachers with joint basic science and clinical expertise, unlike the practice of using teachers with separate un-integrated expertise. Integrated physiotherapy modules containing basic sciences and clinical physiotherapy specialties are much more prevalent in the UK than separated basic sciences and clinical subjects in physiotherapy degree programmes (Bithell, 2007). The CSP and HCPC are more likely to approve the promotion of discreet single subjects, like anatomy, if they are integrated around clinical competencies (HCPC-Training-Further-Information, 2015) and underscores the need for anatomy-teachers-for-physiotherapy to have both anatomical and physiotherapy expertise.

There are other reasons for choosing anatomy teachers with clinical physiotherapy experiences to be participants. Non-physiotherapy anatomy teachers are known to use significantly different teaching strategies from physiotherapy trained anatomy teachers on deciding essential anatomical content for physiotherapy because of being less able to see the clinical relevance of anatomy (Mattingly & Barnes, 1994; McCrorie, 2000). Pure anatomists are good at teaching anatomical details, but weak on teaching clinical information, while clinically trained anatomy teachers are often the reverse (Koens, Custers, ten Cate, & Cate, 2006; McCrorie, 2000; T. M. Scott, 1993). Teachers with knowledge of a single discipline are usually not prepared to expose their lack of knowledge to students expecting integrated knowledge (McCrorie, 2000). The separation of basic sciences from clinical subjects was largely because of the skills that the teachers have (McCrorie, 2000) and having people with both anatomy and physiotherapy skills could help reduce the divide between basic sciences from clinical physiotherapy subjects. Tandem teaching between basic science teachers and clinicians in the same teaching session is very difficult in practice (McCrorie, 2000) and curricular communication between basic science teachers and clinical teachers and their students on clinical placements is known to be poor (T. M. Scott, 1994).

For the purposes of this study, an anatomy teacher for physiotherapy had to fulfil three inclusion criteria:

i. registered as a physiotherapist with the HCPC
ii. employed as a lecturer or higher by a physiotherapy school at an university in the UK
iii. having had experience in teaching anatomy modules to physiotherapy undergraduate students

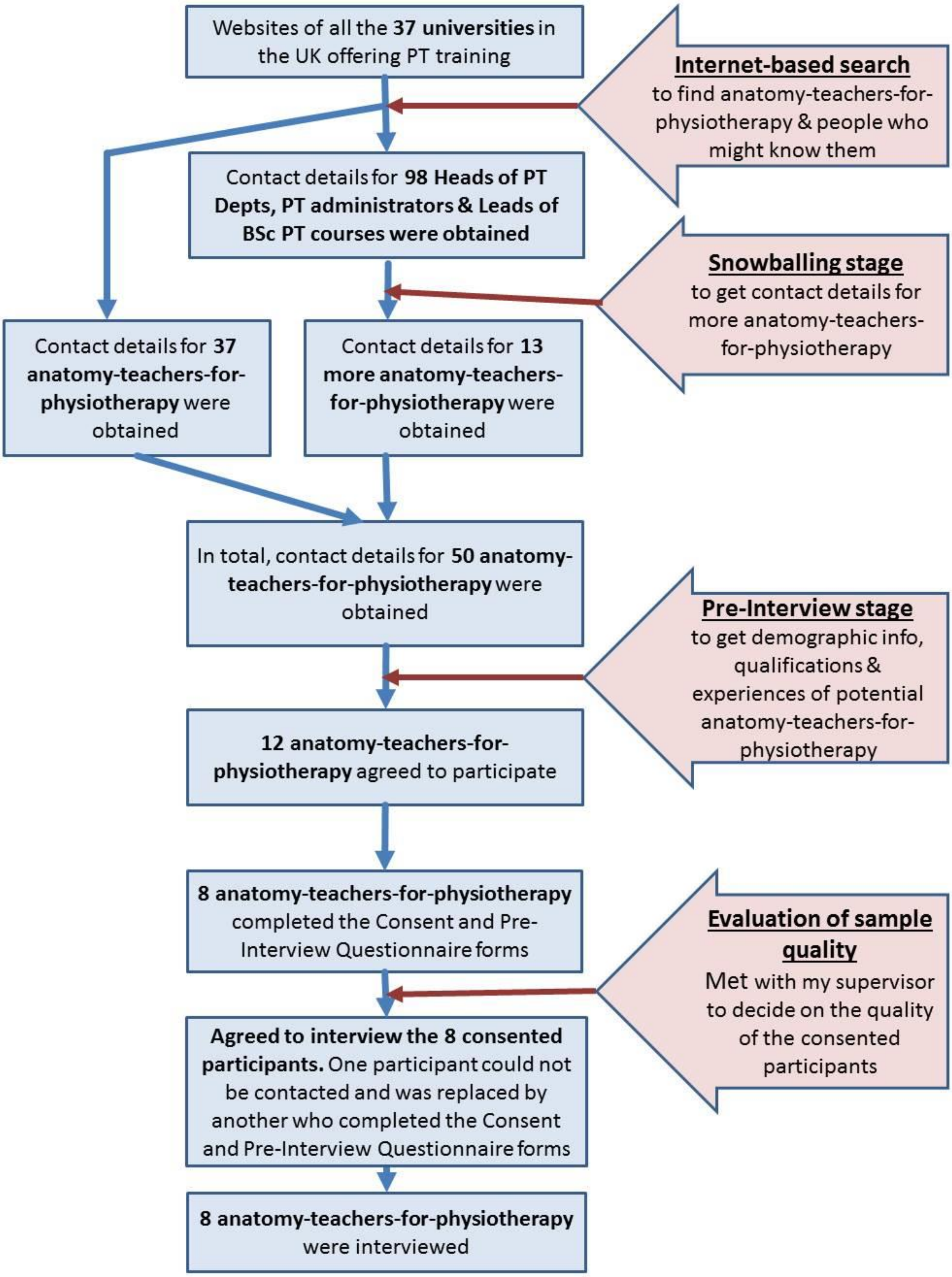
The anatomy teachers for physiotherapy who met the three inclusion criteria will be referred to as 'anatomy-teachers-for-physiotherapy' throughout the rest of the current thesis. Heads of physiotherapy schools, Leads of BSc Physiotherapy programmes, other physiotherapy lecturers and physiotherapy administrators were not suitable participants because they did not have significant first-hand experiences on teaching anatomy modules for physiotherapy greater than for anatomy-teachers-for-physiotherapy. Students were excluded because they have more limited knowledge of anatomy and physiotherapy, and inadequate understanding of the long-term impact of teaching and learning anatomy. Students are less likely to be aware of pedagogical concepts used in teaching them than teachers. The perceptions by students of their anatomical knowledge are much more polarised than the opinions of anatomy teachers (Bergman et al., 2011). The opinions of anatomy teachers usually carry more weight than the opinions of anatomy students (Leung, Lue, Lu, & Huang, 2006).

3.4 Procedure

The Procedure section will describe a three stage initial exploratory sampling, an evaluation of the quality of potential available participants (Patton, 1990) and how the interview data was processed. The exploratory sample technique was meant to find the size of the potential pool of anatomy-teachers-for-physiotherapy within the UK, and their profiles and credentials, because there was no indication of their size from British literature. The three stages of the exploratory sample technique were the systematic internet-based search (described in Section 3.4.1), then snowball sampling to augment and complete the initial contact details from the internet-based search (described in Section 3.4.2) and lastly contacting all the anatomy teachers whose contact details I could get and asking them to complete a Pre-Interview Questionnaire (described in Section 3.4.3).

FIGURE 6 the next page gives a summary overview of how the participants were selected and will be described in greater detail in the subsequent subsections.

Figure 6: A flow diagram of the selection of participants



The Research Proposal for this study was approved by the Research Degrees Sub-Committee of the Faculty of Business, Education and Law of the University of Staffordshire and please find the approval letter in APPENDIX 5 on page 233.

3.4.1 The internet-based search stage

Only training institutions approved by the HCPC are legally allowed to run physiotherapy training programmes (HCPC-Register, 2015). The HCPC has a list of all the 37 approved universities running physiotherapy training programmes in the UK, offering BSc Honours Physiotherapy, Post-Graduate Diploma in Physiotherapy, MSc Physiotherapy degrees and Doctorate in Physiotherapy degrees that enables registration as a physiotherapist (HCPC-Register, 2015). The number of universities offering the pre-registration physiotherapy qualifications (37) has been unchanged since 2007 (Bithell, 2007). One of the listed universities, the London South Bank University, did not have physiotherapy degrees on its website.

The names, email addresses and telephone numbers of anatomy-teachers-for-physiotherapy or key people who might know them, such as the Heads of physiotherapy schools, physiotherapy administrators and the Course Leaders for the BSc Physiotherapy degree programmes were retrieved from the university websites and are tabulated on TABLE 1 in the next two pages. Some of the university websites were so hard to navigate to find details of anatomy-teachers-for-physiotherapy that the Google Search website had to be used (Google-Scholar, 2017) and the combinations of the name of the university, “staff”, “anatomy” and “physiotherapy” words were typed into the search box. The contact details of 37 potential anatomy-teachers-for-physiotherapy, two probable anatomy-teachers-for-physiotherapy and 98 staff members who might know of anatomy-teachers-for-physiotherapy were found. The probable anatomy-teachers-for-physiotherapy were either anatomy teachers who had not mentioned their physiotherapy qualifications or physiotherapy lecturers who had no clear indication that they taught anatomy to physiotherapy students. About 80 hours were spent during the internet-based search stage.

Table 1: Summary of contact details obtained during the internet-based search

	Categories of persons with contact details retrieved									
	Type of starting university website	Heads of PT School	BSc PT Programme Course Leaders	MSc PT Programme Course Leaders	General PT School Contact details	PT Administrators	PT Lecturers (?? Anatomy Teaching)	Anatomy Lecturers (?? PT Qualifications)	PT Lecturers Teaching Anatomy	Other Interesting contacts
Bournemouth University	D	1	0	0	0	0	0	0	0	3
Brunel University	G	1	1	1	0	0	0	0	1	1
Cardiff University	G	0	2	1	1	0	0	0	3	0
Coventry University	G	0	1	1	0	0	0	0	0	0
Glasgow Caledonian University	G	2	0	0	0	0	0	0	2	0
Keele University	G	1	1	1	0	2	0	0	2	1
King's College London	G	2	0	0	1	0	0	0	0	1
Leeds Beckett University	G	0	0	1	0	0	0	0	0	0
London South Bank University Could not find PT degree programme	G	0	0	0	0	0	0	0	0	0
Manchester Metropolitan University	F	1	0	0	0	0	0	0	5	0
Northumbria University	G	0	1	0	0	1	0	0	0	1
Oxford Brookes University	D	1	0	0	1	0	0	0	1	0
Plymouth University	G	0	1	0	0	0	0	0	3	0
Queen Margaret University	G	0	1	1	0	0	0	0	0	0
Sheffield Hallam University	G	0	0	1	1	0	0	0	0	0
St George's, University of London	G	1	0	1	1	0	0	0	0	0
Teeside University	G	0	0	0	2	0	0	0	0	0
The Robert Gordon University	G	1	0	0	0	1	0	0	0	1
University of Birmingham	G	0	1	1	1	0	0	0	1	0
University of Bradford	G	0	0	1	0	4	0	0	0	0
University of Brighton	G	2	0	1	1	0	0	0	0	0
University of Central Lancashire	G	0	0	0	1	0	0	0	0	0
University of Central Lancashire	G	1	2	0	1	0	0	0	2	0
University of Cumbria	G	0	1	0	0	0	0	0	2	0
University of East Anglia	G	0	0	0	1	0	0	0	2	0
University of East London	D	0	2	0	1	0	0	0	0	0
University of Essex	G	1	0	0	0	1	0	0	0	0
University of Hertfordshire	G	0	1	0	1	0	0	0	0	0
University of Huddersfield	G	0	0	0	1	0	0	0	0	0

University of Liverpool	G	1	1	0	0	1	0	1	8	0
University of Nottingham	G	1	1	0	1	1	0	0	0	0
University of Salford	F	2	2	0	1	0	0	0	1	0
University of Southampton	D	0	1	0	1	0	1	0	0	0
University of the West of England	G	3	1	0	0	0	0	0	0	0
University of Ulster	G	1	0	0	1	0	0	0	0	0
University Worcester	G	1	1	0	0	0	0	0	3	0
York St John University	G	1	1	0	0	1	0	0	1	0
Totals		**25**	**23**	**11**	**19**	**12**	**1**	**1**	**37**	**8**

Explaining Abbreviations used	
PT = Physiotherapy	
Type of starting university website = Whether the website given by the HCPC (2015) website was for the main university website (G), Faculty website (F) or the website for the Physiotherapy degree programme (D)	
?? Anatomy Teaching = not sure if the person taught anatomy to physiotherapy students	
?? PT Qualifications = not sure if the person had physiotherapy qualifications	
Explaining Colour codes used	
(yellow)	Means no email address was available
(blue)	Means neither email nor the telephone details were available
(orange)	Means that the university website was not available or pre-registration physiotherapy degree programme could not be found

3.4.2 The snowballing stage

Although some of the contact details from the internet-based search stage were complete, the majority of the information sought was either missing, incomplete or out of date, and the snowballing stage was used to complement and complete the contact details as much as possible. The complete set of contact details of anatomy-teachers-for-physiotherapy (like Heads of physiotherapy schools, physiotherapy administrators and the Course Leaders for the physiotherapy degree programme) was sought by emailing and/or phoning their proxies.

An initial list of 98 proxies of anatomy-teachers-for-physiotherapy (Heads of physiotherapy schools, Leads of BSc Physiotherapy courses and administrators of physiotherapy degree programmes) were sent an email requesting them to snowball the contact email and telephone details of anatomy-teachers-for-physiotherapy who taught anatomy modules or courses within their own physiotherapy school. Follow-up telephone calls were made where there was no reply. Two people forwarded my research participation request to anatomy-teachers-for-physiotherapy in other British universities. Six emails bounced back because they were invalid email addresses or the receiving email system did not accept my attachments. Five contacts forwarded the email to an unknown number of physiotherapists who taught anatomy modules or courses. The initial list of 98 proxies ended up being 142 proxies at the end of the snowballing process. The contact details for 13 more anatomy-teachers-for-physiotherapy were found as a product of the snowballing stage. The snowballing phase took about 30 hours during normal working hours spread over four weeks.

3.4.3 The pre-interview survey stage

The contact details of a total of 50 anatomy-teachers-for-physiotherapy were obtained from both the internet-based search (37 participants) and the snowballing stages (13 participants), and will be referred to as the potential participants. The pre-interview stage was used to reveal the demographic data, qualifications and experiences of the 50 potential participants that were then used to evaluate the list of anatomy-teachers-for-physiotherapy that had signed consent forms. The Research Information Sheet, Consent Form and the Pre-Interview Questionnaire Form were sent in one go to the 37 potential participants from the internet-based search, but were sent out sporadically to a further 13 further potential participants from the snowballing stage as soon as I received their contact details.

3.4.4 The evaluation of consented participants

Twelve out of 50 (24%) anatomy-teachers-for-physiotherapy agreed to participate, but only eight (16%) initially completed the Consent forms despite further email and phone calls reminders. A meeting was held between one of my EdD Supervisor and myself to evaluate the quality of the eight anatomy-teachers-for-physiotherapy with signed consent forms and we decided that I should start interviewing them because of a number of reasons. The eight confirmed participants had a good mix of old vs young teachers, doctorate vs non-doctorate holders, a wide spread of amount of years spent teaching anatomy and of teaching loads per week, and had equal numbers of males and females.

One of the eight consented participants did not reply to my two further emails reminders and was not contactable on their telephone numbers four times over a three week period. Further emails and phone calls were made to the remaining potential anatomy-teachers-for-physiotherapy who had not agreed and one was found to replace the uncontactable anatomy-teacher-for-physiotherapy and signed the consent form. Thus in conclusion, 13 out of 51 (25%) anatomy-teachers-for-physiotherapy agreed to participate, only nine (18%) completed the Consent forms and eight (16%) were available for interviews.

3.4.5 Pilot interview

A pilot interview with an anatomy teacher for medical students was conducted prior to the interviews with the anatomy-teachers-for-physiotherapy and helped refine the Interview Schedule and the process of interviewing. The audio recording equipment was tested beforehand and calibrated. After the interview, the audio files were converted from wav formats to mp3 formats, and then sliced into 25MB segments successfully without loss of audio quality. The pilot interview highlighted the need to maintain a high degree of multitasking of at least seven cognitive activities simultaneously and these are:

1) keeping track of what the participant said earlier in the interview and is currently saying
2) scribbling notes along the way
3) asking for clarifications
4) checking if I understood what the participant was saying by repeating what he/she was saying in my words
5) going back to the scribbled notes to ask questions necessitated by more recent information
6) monitoring time and the progress on the overall Interview Schedule layout and where I was on it
7) frequently checking if the audio recorder is still recording

The interview process made me more aware that I should replace some of the technical terms with laymen's terms and improved the flow of the structure of the interview. Consequently, the original Pre-Pilot Interview Schedule shown in APPENDIX 6 on page 234 was upgraded to make the Post-Pilot Interview Schedule in APPENDIX 7 on page 235.

3.4.6 Conducting the interviews

Originally face-to-face interviews were planned with participants who lived less than 150 miles from Birmingham and Skype/telephone interviews with participants who were based over 150 miles away because it would have been more costly to travel further than 150 miles on a self-funded research project and pay for overnight accommodation. There was one exception where a participant less than 150 miles from Birmingham was eventually given a Skype interview after he cited personal reasons. One Skype interview had such a poor video and audio quality that a telephone interview was conducted instead. Two participants less than 150 miles away were given face-to-face interviews on the same day to save on transport costs. In total, six face-to-face interviews, one Skype Interview and one telephone interview were carried out.

The batteries of the audio recorders were fully charged the night before the interviews. I went to the interviews with two audio recorders, a Research Information Sheet, the signed consent form, the completed Pre-Interview Form and a notebook. The sequence of the interviews generally followed the Post-Pilot Interview in APPENDIX 7 on page 235.

3.4.7 Processing of interview data

The interviews were audio recorded on a J5 Samsung handset and three software applications were used. A backup recorder was used in case there were any recording problems with the first recorder. The 'Smart Voice Recorder' software application (version 1.7.1 made by SmartMob) encoded the audio files on a wav audio format 44.1kHz (CD quality) setting. The 'Media Converter' software application (Version 0.8.0 by Antvplayer) converted and compressed the large wav audio files to a smaller sized format of mp3 audio files with a bit-rate of 128kb/s, and was a move towards being able to email the interview audio files to the transcribers. One hour of wav audio files was about 310MB and converting it to mp3 audio files reduced the size to about 57MB. The limit of attachments on my email account was 25MB per email and the mp3 audio files were further sliced into two or three segments of less than 25MB each using the 'MP3 Cutter' software application (Version 1.1.4 made by Accountlab). Both the wav and mp3 audio files for each of the eight participants were stored on a password protected computer and the mp3 audio files were also backed up on a password protected cloud computing storage facility, in case my computer failed.

The eight interviews amounted to a total of 8 hours 55 minutes that generated 72 292 words when transcribed. The duration of interviews and number of words per participant are shown in GRAPH 2 on page 74. Each audio hour of interviews took one of the three transcribers about six to eight hours to transcribe because of the presence on many technical anatomy and physiotherapy terms. Three transcribers were used because one transcriber could not manage to have time for all the eight interviews, which took an estimated combined 50-80 hours to complete.

Each transcriber was given the same format to present the typed transcript in. The eight participants were named A, B, C, D, E, F, G and H respectively and the TABLE 2 below shows the requested format:

Table 2: Formatting instructions for the transcribers

I would be happy if you (the transcriber) could transcribe as follows: i. H = Hope A = Participant H - How are you feeling? A - I am feeling feverish. H - I am sorry, since when? A - Since four months ago. Etc ii. Please try to include verbal expressions such as 'eem', 'yaa' etc into the transcript iii. Interjections by the other person can be put in brackets e.g. H - So you have been coughing a lot? (ya , ya , ya) Oh I see.

The transcribers were not familiar with some of the technical anatomy and physiotherapy terms and could have mis-transcribed them. Thus, I spent a further four hours for each audio hour of transcription checking the accuracy and spent about 40 hours in total. I also explained technical anatomy and physiotherapy terms in the transcripts in laymen's terms and placed them in brackets in the transcripts.

3.5 Analysis of interview transcripts

3.5.1 Analysis of contextual information

Understanding the educational contextual background was important for analysing major pedagogical concepts. The regulatory context of running physiotherapy training schools has already been considered in an earlier Literature Review Module (in APPENDIX 29 from page 299) and, is dominated by the CSP and HCPC institutions. Contextual analysis of the profiles of the participants, their universities and students were made before the analysis with coding techniques.

During the selection of final participants with my supervisor, information from the eight Pre-Interview Questionnaires and information available on the internet was used to characterise the profiles of the universities and physiotherapy students in the eight physiotherapy schools.

The physiotherapy student profiles that helped to give comparisons among the various physiotherapy schools were the percentages of applicants receiving offers from the physiotherapy schools, percentage of overall student satisfaction, percentages of students receiving at least a 2.1 physiotherapy degree class or higher and percentages of students not progressing beyond the physiotherapy first year. The other parameters were the percentages of international physiotherapy students and the gender balance, and all the parameters are discussed in Section 4.2.2 starting from page 80. The information obtained from the eight Pre-Interview Questionnaires was largely used (and the information from the interviews to a less extent) to create the mini-case overviews of each participant in Section 4.2.1.1 starting on page 76. The internet sources will not be disclosed because it may allow the identification of the universities involved. The reference to years used to describe the student profiles (in Section 4.2.2 starting from page 80) and mini-case studies of participants (in Section 4.2.1.1 starting on page 76) was rounded off to the nearest five years to maintain anonymity of the participants. The contextual analysis of Programme Specification documents of the various BSc Physiotherapy degree programmes was triggered by the interview discussions and was driven by the desire to understand the local context of running BSc Physiotherapy programmes. The contextual analysis of the Programme Specifications was done after the interviews, but before the analysis using coding techniques. The Programme Specification documents of five of the eight physiotherapy schools were found after an online search and were useful in indicating the dominant pedagogical principles and educational philosophies guiding the teaching and learning of the BSc Physiotherapy degree programmes. The Programme Specifications are required every five years by the regulatory CSP (CSP-Accreditations, 2016) and I used the latest versions for this study. The Programme Specifications were also used together with information on the websites of the physiotherapy schools to find out where the anatomy modules were located within of the BSc Physiotherapy degree programme and the findings are listed in APPENDIX 15 from page 246.

3.5.2 Analysis using coding techniques

The coding strategy was decided upon before the start of the pilot interview, as indicated in the research timeline in TABLE 6 and TABLE 7 starting on page 66. The coding process was guided by coding techniques recommended for grounded theory methodology by a leading world expert on coding techniques, Professor Johnny Saldaña (Saldaña, 2013). Saldaña's coding techniques were more extensive, clearer and better argued (Saldaña, 2013) than the coding techniques by Strauss, one of the inventors of grounded theory (Strauss & Corbin, 2008). Saldaña recommended first and second cycles of coding techniques for grounded theory methodology and they were all used in the current study except for the Longitudinal and Elaborative coding techniques (Saldaña, 2013). Longitudinal coding would have required a series of interviews with each participant and longer timescales beyond the time limits of the EdD programme. Elaborative coding was not appropriate because it requires further exploration of an existing substantial theory, of which there was none available. The first cycle of coding techniques used in the study were the Descriptive, In-vivo, Process, Initial, Versus, Evaluation and Causation coding techniques, while the second cycle included Pattern, Focused, Axial and Theoretical coding techniques.

I created a table with 13 columns and probably about 800 rows spread across several A3 pages to assist the coding analysis for each participant interview. Each coding analysis sheets for each participant were printed on differently coloured papers to help me more easily identify between the sheets from different participants during analysis. A copy of the table showing the first and second cycle of coding techniques used are shown in TABLE 3 and TABLE 4 below, where TABLE 4 is a continuation horizontally of TABLE 3. The table has been split into two to make the font bigger on an A4 paper.

Table 3: First Cycle of Coding Techniques Used

Transcript	**First Cycle of Coding Techniques Used**						
	Descriptive	**In-vivo**	**Process**	**Initial**	**Versus**	**Evaluation**	**Causation**
<u>Meaning of different fonts</u> • *Italics* - my personal comments) • **In Bold** - Significant quotations	Describing what is happening	Peculiar words in the interview	Describing the activity occurring and usually ending in '-ing'	Breaking into discrete parts & exploring their relationships	Conflicting concepts/people /system, processes/phenomenon	+ve or –ve evaluation of a topic, subtopic, recommendation	What is causing the phenomenon
1st Sentence							
2nd Sentence							
3rd Sentence							
Etc.							

Table 4: Second Cycle of Coding Techniques Used

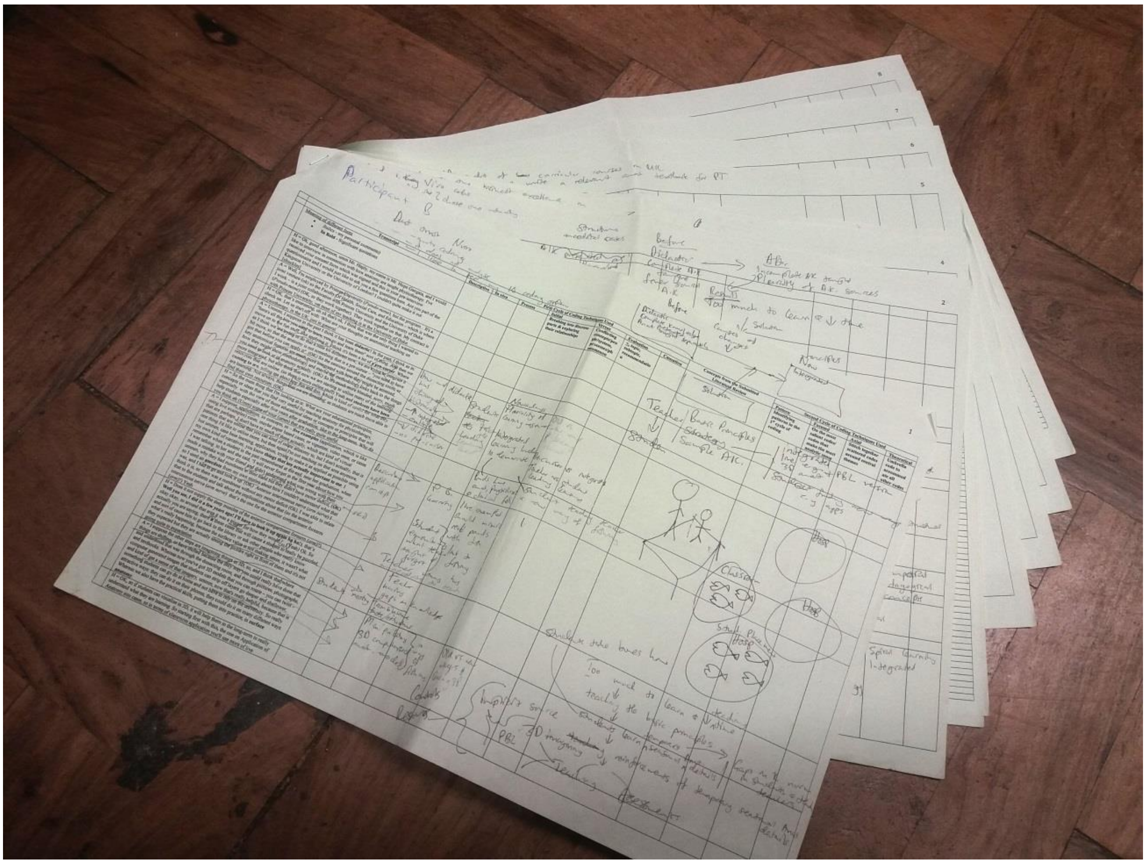
Transcript	**First Cycle of Coding Techniques Used**	**Concepts from Literature**	**Second Cycle of Coding Techniques Used**			
			Pattern	**Focused**	**Axial**	**Theoretical**
<u>Meaning of different fonts</u> • *Italics* - my personal comments) **In Bold** - Significant quotations			Identifying patterns in the 1st cycle of coding	The most salient codes/ codes that make the most analytic sense	Stitch together scattered codes around central themes	Umbrella code to accommodate all other codes
1st Sentence						
2nd Sentence						
3rd Sentence						
Etc.						

A transcript for a participant was copied and pasted into the first column in such a way that each sentence or paragraph was placed in each row and permitted particular coding techniques to be applied to each sentence or paragraph. The next seven columns were for the first cycle of coding, while the last four were for the more advanced second cycle of coding techniques. There was a column, between the first and second cycles of coding techniques, for concepts mentioned by the interviewees related to concepts in the Literature Review of Module 5 in APPENDIX 29 from page 299, the Literature Review in Chapter 2 from page 7 or concepts which required a fresh literature exploration. Some sentences or paragraphs in transcripts were coded with more than one code, but some had none. Some codes were allocated to a number of sentences or to multiple paragraphs.

Themes and concepts that were related were connected with pencil or pen drawn up lines and memo comments were written on the coding analysis sheet.

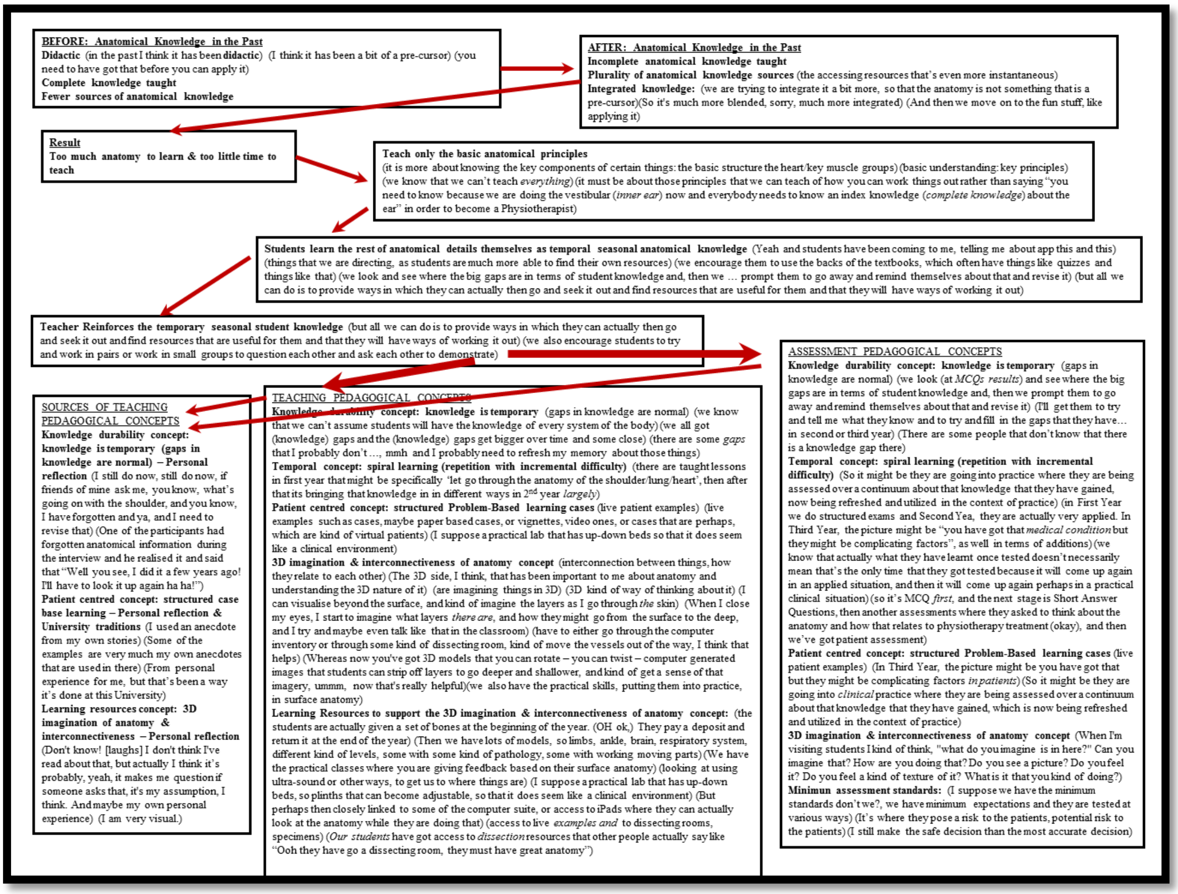
FIGURE 7 below shows the coding analysis sheet of the first participant as an example.

Figure 7: An example of memo notes and lines drawn on a coding analysis sheet



The emerging themes were then drawn into a coherent and summarised memo diagram for each participant and the themes were underpinned by supporting quotations from the particular participant. An example of a summarised memo diagram is FIGURE 8 on the next page.

Figure 8: An example of a summarised memo diagram



NB: The diagram was printed on an A3 paper size and explains why the font is too small. The sentences not in bold were the supporting quotations from the particular participant.

The eight summarised memo diagrams were useful in finding patterns across the eight participants and were aggregated to make a master summarised memo diagram illustrating the major pedagogical themes of the eight transcripts. The radical constructivism epistemology allows the knowledge of individuals to be 'taken-as-shared' knowledge (Cobb, Yackel, & Wood, 1992).

Strong strands of pedagogical themes emerged after analysing the third participant onwards and the data was saturated from the sixth participant onwards, i.e. no new pedagogical concepts arose after the sixth participant. Initially, I was hoping to interview about 15 participants in the Research Proposal in APPENDIX 31 on page 359, since it was the point at which I had expected to see data saturation of the concepts to emerge. The major themes that emerged from the master summarised memo diagram were the three Pedagogical Backdrop (starting from page 84), Pedagogical Approaches (starting from page 87) and the Pedagogical Timings (starting from page 99) of the Findings Chapter. The major themes were grounded and anchored in the interview transcripts by the location and compilation of 142 supporting quotations that have been placed throughout the Findings Chapter and assisted in preserving the thoughts of the participants during the analysis stage, as recommended by Charmaz (Charmaz, 2014). The coding analysis stage took about 300 hours.

I seriously considered using software for the coding analysis as an alternative to conducting manual coding analysis. I attended a formal training session on NVivo software for managing the grounded theory, (Nvivo training booking is in APPENDIX 8 on page 236). I also watched several training videos on Nvivo and the most notable was (Rowe, 2014). I, however, preferred the paper-based approach because I could more easily put my own annotations and arrows all over the pages to connect themes and I felt that the software restricted the connection of some ideas and themes because it was not programmed to do so.

3.5.3 The role of documents during my analysis

The role that documents can play in grounded theory methodology varies tremendously from being the mainstay of data (Star & Griesemer, 1989), being used as a compromise in conjunction with the interviews (Chen, 2011) and in the extreme end of not being used at all (Glaser & Strauss, 2006; Glaser, 2002; Holton, 2007; Nathaniel, 2006). The variation is partly due to the different epistemologies used. In radical constructivism, knowledge only exists in the minds of people because knowledge is created cognitively and cannot exist in books and documents, unlike positivism, where knowledge can exist 'out there' without people (Neuman, 2005; Sarantakos, 2005). In the current study, the role of documents depends on the level of the three levels of constructing knowledge based on the radical constructivism epistemology described in Section 3.2 on page 40. Documents were not used for constructing knowledge of the dominant pedagogical concepts of the anatomy-teachers-for-physiotherapy, because it is much harder to distil the dominant pedagogical concepts from a collection of anatomy teaching and curricular documents. Anatomy teaching and curricular documents are usually written by a team of academics and make it hard to attribute and trace back pedagogical concepts to a particular participant. Anatomy teaching and curricular documents were likely to be difficult to access and the academics may be reluctant to share these documents with people outside of their university system. I had not expected that the participants would have written down their pedagogical thoughts, although it later emerged that only two participants had written on pedagogical ramifications for teaching anatomy for physiotherapy, which were multi-authored and hard to attribute to the research participant. Even if there was a peer-reviewed and single authored paper of a partaking participant, it is not certain if pedagogical concepts described were one of their most dominant for teaching anatomy for physiotherapy. Although documents were not used to determine dominant pedagogical concepts of the anatomy-teachers-for-physiotherapy, the documents were used by the researcher to construct contextual knowledge during the second stage of constructing knowledge. This thesis document is also being used by the reader of this thesis in constructing knowledge of the dominant pedagogical concepts.

3.5.4 Care taken during the construction of knowledge in the analysis stage

3.5.4.1 Using my prior interpretations and knowledge

My own interpretations and knowledge gained from my past experience of teaching anatomy and practising physiotherapy influenced how I interpreted the interviews, analysed coding, rearranged and created axial and peripheral themes. The participants frequently mentioned technical anatomy and physiotherapy terms during the interviews and my knowledge and interpretation of them helped me to better understand what the participants meant.

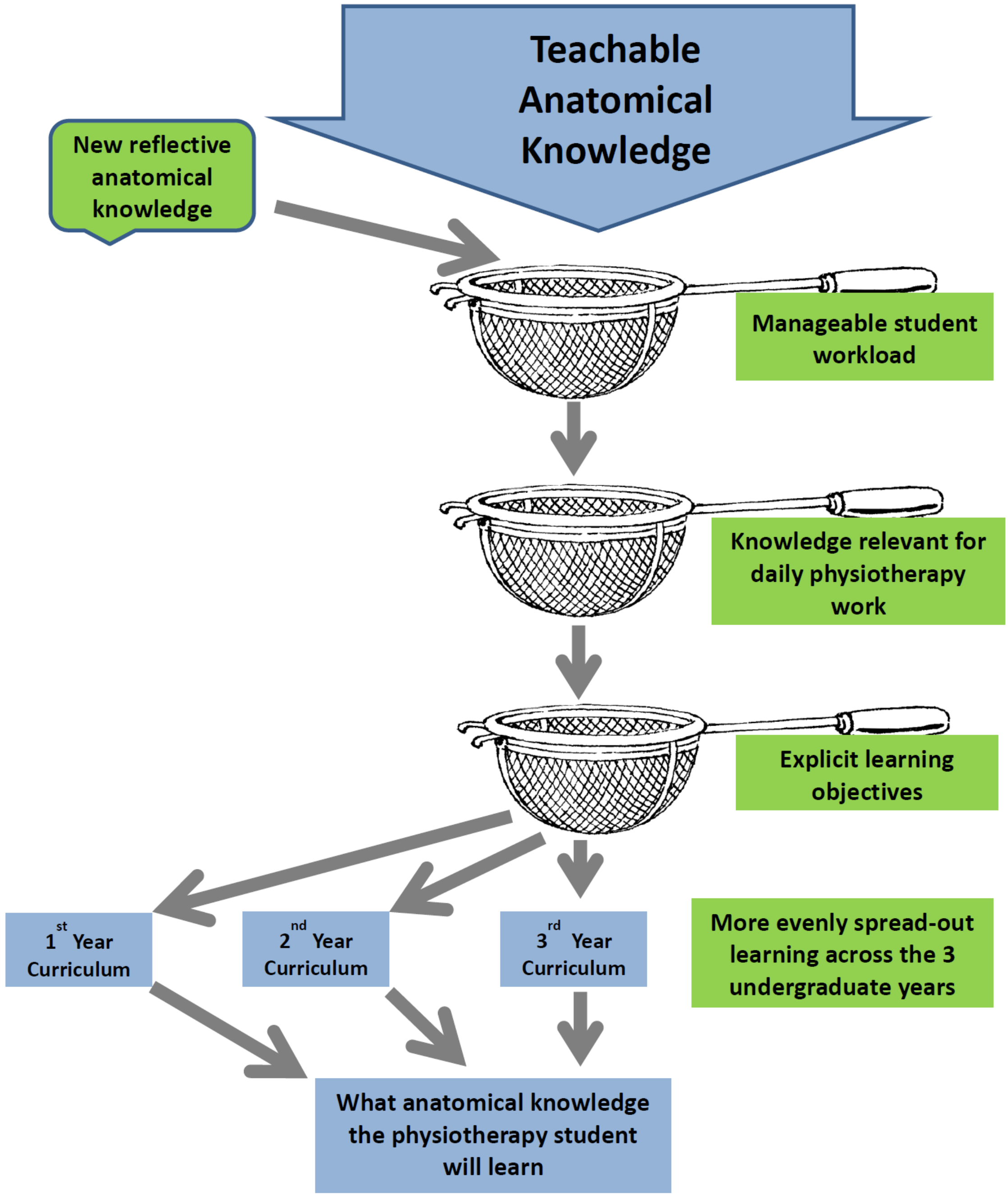
There is a debate among grounded theory scholars on the timings of the literature review in relation to data analysis and how it affects the analysis and interpretation of results (Dunne, 2011). Reading literature 'before-the-interview-start' is thought to encourage contamination of ideas in the literature into the study (Charmaz, 2014; Glaser & Strauss, 2006; Glaser, 1998, 2002; Holton, 2007; Nathaniel, 2006) and there are fears that literature is too immense to be properly reviewed (Glaser, 1998). On the other hand, reading literature 'before-the-interview-start' helps to provide research justification for funding and ethical approval (Dunne, 2011), avoiding research duplication (Chiovitti & Piran, 2003), identifying areas needing research and being aware of methodological blind spots (McGhee, 2007). I adopted the 'before-the-interview-start' and read extensively on pedagogical concepts beforehand and that prior knowledge helped to identify some of the concepts that arose during the analysis stage, and were entered in the third column in TABLE 4 on page 57. The next section shows the care that I took to avoid unconscientiously influencing the research outcome with my own preferred ideas.

3.5.4.2 My preferred personal pedagogical concepts

Although my prior knowledge of anatomy, physiotherapy and educational pedagogy was beneficial in interpreting and analysing the transcripts, my own pedagogical opinions could subconsciously influence my interpretation, coding and data analysis of the pedagogical concepts of the participants. I compiled my own preferred set of pedagogical concepts described below and gave my two supervisors a copy before the start of the interviews to help safeguard against unduly influencing the results of this study. My pedagogical preferences are the product of reflection on my 16 years of teaching anatomy at four different universities in three countries, where I and studied four earned degrees across physiotherapy, anatomy and education fields. I later compared my preferred opinions with the pedagogical concepts that emerged from the study in Section 6.5.1 on page 172 and reviewed my unconscious influence.

The outline of my pedagogical preferences can be referred to as the 'Sieving Teacher Approach', as illustrated in FIGURE 9 on the next page with its five main elements shown in Green boxes. The anatomy teacher determines what anatomical knowledge to teach by passing potential anatomical content through three filtration sieves. The teacher plays a critical role during the learning by students, by determining what anatomical knowledge the students should learn and how the anatomical knowledge is delivered. 'New reflective anatomical knowledge' is taught with other teachable anatomical knowledge and added into the first sieve of 'Manageable student workload'. What will be filtered by the first sieve will be further sieved by the next sieve called the 'Knowledge relevant for the daily physiotherapy work' sieve and the third consecutive sieve is the 'Explicit learning objectives' sieve. Lastly, the resultant anatomical knowledge with clear and explicit learning objectives has to be carefully spread over the entire three years of undergraduate training. The 'Sieving Teacher Approach' highlights the refining of anatomical content that a tertiary education teacher has to do for his/her students because the knowledge field at tertiary education levels can be vast, but has to be delivered within limited time and other resource constraints. Unlike teachers in tertiary education, primary and high school teachers fortunately do not have to narrow their curriculum because the national curriculum of schools susually narrows it down for them.

Figure 9: The 'Sieving Teacher Approach'



The first Green Box of 'New reflective anatomical knowledge' highlights the need for the teaching of anatomy to encourage reflective thinking in students, to levels where students can generate new unforeseen knowledge. The teaching and assessments should promote the creation of anatomical knowledge in students that is beyond the anatomical knowledge that is found in anatomy textbooks. Future physiotherapy graduates will need to be able to be reflective in how they use anatomical knowledge in order to be relevant in dynamic and unpredictable future professional roles, especially where the scope of the physiotherapy profession is being continually broadened (CSP-Scope, 2008).

The second Green Box on ‘Manageable student workload’ points to that the workload on students of learning anatomy should be manageable and feasible within the available time. If there is less teaching time available in comparison to what is expected to be taught, then the anatomical content has to be proportionally reduced. Overloaded anatomy courses tend to encourage fragile, superficial and rote learning, which does not endure, and the knowledge is less likely to be remembered or to be useful in future (J. Anderson & Graham, 1980; Russell, Hendricson, & Herbert, 1984).

The third Green Box on ‘Knowledge relevant for the daily physiotherapy work’ stands to indicate that anatomical knowledge learnt ought to be relevant for the physiotherapy profession (Latman & Lanier, 2001), if anatomy is to be justified as an integral part of the university physiotherapy training. The bulk of the undergraduate anatomical content should support the core knowledge and skills that will be used by an entry-level physiotherapist, especially anatomical content that is being used frequently in clinical settings or is more important in explaining the more severe injuries/disorders. The fourth Green Box on ‘Explicit learning objectives’ is meant to portray that anatomy should have explicit learning outcomes, which are given to the students and the rest of the teaching team. The explicit learning outcomes will guide anatomical teaching activities (such as planning, teaching, assessments and reviewing) among the many various teaching staff and should guide the use of time spent by students for scheduled and independent learning. Lack of explicit learning outcomes may result in students wasting time in learning irrelevant anatomical knowledge which may not help their future physiotherapy professional work.

The fifth Green Box on more spread-out learning highlights that anatomical learning ought to be spread across all the three years of undergraduate rather than rushed learning of anatomy in one semester or one learning block of time. More paced-out anatomical learning encourages better reinforcement of learning, application of knowledge in varied settings, allows time for student reflection of anatomical knowledge, and discourages rote learning and examination cramming.

3.6 Research Administration and Management

3.6.1 Ethical considerations

Ethical approval was a mandatory requirement of the EdD research process because it helps to protect the participants, myself, the university and the reputation of the research community at large (Burgess et al., 2006; Neuman, 2005; Sarantakos, 2005). Part of the application process for ethical approval involved showing the Ethics Committee documents I wanted to use, or give the potential or definitive participants. The documents used during and for the interviews, their purposes, sources and where they are located in the thesis are shown in TABLE 5 below.

Table 5: Documents used for or during the interviews

Name of Instrumentation	Purpose	Source of Instrument	Location in Appendices section
The Post Pilot Interview Schedule	The general order of how the interviews proceeded	Was designed by the author	APPENDIX 7 on page 235
Research Information Sheet for Participants	To inform participants of the research in layman's terms	Was modified from the Template for participant information sheet from the City University London (City-University-London, 2015)	APPENDIX 9 on page 237
Participant Consent Form	To collect signatures of willing participants	Was modified from the Research Ethics: Sample Consent Form RE5 from the University of Bolton (University-of-Bolton, 2015)	APPENDIX 10 on page 239
Pre-Interview Questionnaire Form	To collect the brief teaching profiles in order to select the most information rich participants	Was designed by the author	APPENDIX 11 on page 240

Ethical approval for the research study was given by the Research Ethics Committee of the Faculty of Business, Education and Law of the Staffordshire University on condition that I made some minor changes that could be signed off by my supervisor. A copy of the approval letter with suggested amendments from the Ethics Committee is shown in APPENDIX 12 on page 242 and an email from my supervisor confirming that I had made acceptable changes is APPENDIX 13 on page 244. Audio recordings of the interviews were kept and stored according to the university guidelines and the requirements of the Data Protection Act (1998). No harm was expected or done to the participants. Participant confidentiality was preserved and quotations were used in such a way that it could not be traced back to the participants. All the eight participants and their universities were given pseudonyms, as shown in TABLE 9 on page 73. Participants were told that they could stop participation at any stage if they so wished, but none actually withdrew.

3.6.2 Research Timelines

The timescales of key stages of the current research process are illustrated in TABLE 6 and TABLE 7 on the next two pages. The timescales were compiled by following an audit trail of respective email communications with my supervisors, Ethics Committee, EdD administrators, participants, potential participants, snowballing proxies of anatomy-teachers-for-physiotherapy and transcribers.

Table 6: Timelines of the current research study (Part A)

Timeline of Stages	**Duration**	**Already Done**	Mont h	Mont h	Month	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	Week 6	Week 7	Week 8	Week 9	**Week 10**	**Week 11**	**Week 12**	**Week 13**	**Week 14**
Month			May 2015	Jun 2015	Jul 2015	Aug 2015					Sept 2015				Oct 2015				
Week starting			1-May 2015	1-Jun 2015	1-Jul 2015	1-Aug 2015	8-Aug 2015	15-Aug 2015	22-Aug 2015	29-Aug 2015	5-Sept 2015	12-Sept 2015	19-Sept 2015	26-Sept 2015	3-Oct 2015	10-Oct 2015	17-Oct 2015	24-Oct 2015	31-Oct 2015
Research Proposal Stages																			
Informal preliminary Literature Review	1.5 years	Jan 2012 to Jun 2013																	
Designing the Research (Ontology, epistemology, methodology and method deliberations) – Passed Module Assignment in APPENDIX 28 on page 264	1 year	July 2013 to July 2014																	
Literature Review of the Research thesis – Passed Module 5 in APPENDIX 29 on page 299	9 months	Aug 2014 to April 2015																	
Writing up Module 6 - Research Proposal in APPENDIX 31 on page 359 and the Completed RCD1 Form in APPENDIX 30 on page 348	4 months																		
Marking of Module 6 - Research Proposal in APPENDIX 31 on page 359 and the Completed RCD1 Form in APPENDIX 30 on page 348	11 weeks																		
Participant Selection Stages																			
Internet Based search for Participants	3 weeks																		
Ethical Approval	3 weeks																		
Snowballing Stage - Telephoning Physiotherapy Schools to confirm or acquire contact details of potential anatomy-teachers-for-physiotherapy	4 weeks																		
Pre-interview Survey (Sending the Research Information Sheet, Consent Form, Pre-Interview Questionnaire Forms to the participants to complete, sign and return back)	6 weeks																		
Analysing the returned the completed Pre-Interview Questionnaire Forms	6 weeks																		
Meeting with supervisors to evaluate the quality of participants	1 week																		
Booking interview appointments with participants	6 weeks																		
Interview Stages																			
Pilot Interview	1 week																		
Interviews stage	9 weeks																		
Transcribing interviews stage	11 weeks																		
Familarisation with the range of coding techniques for grounded theory	3 weeks																		
Analysing Transcribed Interviews using coding techniques	4 months																		

Table 7: Timelines of the current research study (Part B)

Timeline of Stages	**Duration**	Week no.	Week 15	Week 16	Week 17	Week 18	**Week 19**	**Week 20**	**Week 21**	**Week 22**	**Month 9**	**Month 10**	**Month 11**	**Month 12**	**Month 13**	**Month 14**	**Month 15**	**Month 16**
		Month	Nov 2015				Dec 2015				Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016
		Week starting	7-Nov 2015	14-Nov 2015	21-Nov 2015	28-Nov 2015	5-Dec 2015	12-Dec 2015	19-Dec 2015	26-Dec 2015	2-Jan 2016	1-Feb 2016	1-Mar 2016	1-Apr 2016	1-May 2016	1-Jun 2016	1-Jul 2016	1-Aug 2016
Interview Stages (Continued)																		
Interviews stage	9 weeks																	
Transcribing interviews stage	11 weeks																	
Analysing transcribed interviews using coding techniques	16 weeks																	
Post Interview Stages																		
		Month 9	**Month 10**	**Month 11**	**Month 12**	**Month 13**	**Month 14**	**Month 15**	**Month 16**	**Month 17**	**Month 18**	**Month 19**	**Month 20**	**Month 21**	**Month 22**	**Month 23**	**Month 24**	**Month**
		Jan 2016	Feb 2016	Mar 2016	Apr 2016	May 2016	Jun 2016	Jul 2016	Aug 2016	Sept 2016	Oct 2016	Nov 2016	Dec 2016	Jan 2017	Feb 2017	Mar 2017	Apri 2017	
Research write-up – Findings Chapter	2 months																	
Searching for a Theoretical Framework for analysing the Discussion Chapter	2 months																	
Research Write-up – Discussion Chapter	3 months																	
Research Write-up – Recommendations, Personal Reflections and Conclusions	2 months																	
Research Write-up – Research Design Chapter	1 month																	
Research Write-up – Literature Chapter	1 month																	
Research Write-up – Writing Draft 1 of the entire thesis	2 month																	
Supervisors reviewing Draft 1 of the entire thesis	1 month																	
Addressing comments from my supervisors on the Draft 1 of the entire thesis	2 month																	
Submitting the Final Complete Version of the entire thesis	1 month																	
Oral Defence of the EdD thesis																		
Amending the thesis based on recommendations of the Examining Team in Appendix 34 on page 390																		May-Sept 2017
Submission of the Amended EdD thesis																		Oct 2017

3.6.3 Research costs

The costs associated with the current study were relatively low and are indicated in TABLE 8 below. The current study research was designed to be feasible and low cost because I was self-funding the study.

Table 8: Costs incurred in conducting the research

Expenditure	Actual costs	Projected costs	Notes
Interview travelling costs	£200	£300	The travelling budget was only for the six participants within a radius of 150 miles. Travel between cities was by train. Costs include intra-city travel costs and the cost of my refreshments and lunch.
Telephone costs	£50	£100	Telephone costs incurred during the snowballing stage and for the telephone interview with one participant
Transcription	£300	-	For paying transcribers
Stationary, printing and photocopying of documents and forms	£100	£100	
Printing thesis	£400	£250	Printing three soft bound and three hard bound book copies
Total Budget	**£1050**	**£750**	

3.7 Strengths and limitations of the Research Design

The research design had a number of strengths and limitations. There were at least six major strengths associated with the current research design. Firstly, an elaborate, extensive and time consuming procedure of the internet-based search and snowballing stages was carried out to compile a list of potential anatomy-teachers-for-physiotherapy because they were difficult to locate. The difficulty was in part because the entire population of anatomy-teachers-for-physiotherapy for the UK is relatively small and probably number less than 100. In some physiotherapy schools, anatomy for physiotherapy was taught by anatomy teachers without any physiotherapy training and it reduced the available pool of anatomy-teachers-for-physiotherapy.

Secondly, there was a deliberate and critical exploration of important research design planning stages that are commonly ignored or assumed, such as the ontology, epistemology and methodology. These research design issues helped improve the clarity and focus of the research design. Thirdly, the pilot interview helped to refine the clarity of the Interview Schedule and raising the importance of multitasking by the interviewer during the interview. Fourthly, the processing and handling of the interview audio files was excellent. The clarity of the recorded audio files was very good, even after converting from wav formats to mp3 formats, slicing the mp3 files into 25MB segments and emailing the transcribers.

Fifthly, care was taken against unconsciously allowing my own preconceived pedagogical concepts from unduly influencing the analysis outcome of the pedagogical concepts of the anatomy-teachers-for-physiotherapy. My pre-interview pedagogical concepts were compared with the eventual pedagogical concepts of the anatomy-teachers-for-physiotherapy in Section 6.5.1 on page 172.

Sixthly, facial expressions, gestures and emotional undertones in the interviews helped to interpret the descriptions that the participants gave during the six face-to-face interviews and not in the one telephone interview. The lack of facial expressions in the telephone interview made it harder for me to tell whether if the silence after a sentence was due to a participant thinking of what to say next or was waiting for me to say the next thing. Some of the emotional expressions of the participants and clarifications of technical anatomy or physiotherapy words were tracked by putting them in brackets in the transcripts.

The limitations of the study centred on the difficulty of finding anatomy-teachers-for-physiotherapy to participate in the study. Conducting the interviews coincided with the start of the first semester, as indicated in the research timeline in Table 6 and Table 7 starting on page 66. A number of potential anatomy-teachers-for-physiotherapy indicated that they were too busy with the start of the new semester and teaching to participate in the study. Perhaps having conducted the interviews at less busier times could have increased the pool of definitive anatomy-teachers-for-physiotherapy. However, despite the difficulty of accessing a wider sample, I am confident in the sample used.

The difficulty of locating anatomy-teachers-for-physiotherapy was compounded by the poor design of most of the websites of the universities. The majority of the websites did not have webpage/s for the physiotherapy schools, where the profiles of the teaching staff could be found, but all the universities had a dedicated webpage with information for prospective applicants wanting to train as a physiotherapist. Some of the university websites were outdated and showed the profiles of anatomy-teachers-for-physiotherapy who had left the university, while some email addresses were no longer valid. Some staff profiles were very scant, although some profiles were richly described in terms of the biography, teaching, research and list of publications. Some of the phone calls were unanswered, even after repeated calls, and it was not certain if the potential participants were away on holiday or away from their offices in meetings each time I called. During the snowballing stage, some proxies forwarded my email to an unknown number of anatomy-teachers-for-physiotherapy and did not tell me to whom they had forwarded it to. It made it hard for me to know how many potential anatomy-teachers-for-physiotherapy actually received my research participation documents.

Another potential limitation of the research design was that only a small group of eight anatomy-teachers-for-physiotherapy were available for interviews. However, data saturation was achieved after analysing the sixth participant onwards, despite the variable profiles of the anatomy-teachers-for-physiotherapy, and allays fears of an inadequate sample size of participants. Another possible limitation was that the qualifications of the anatomy-teachers-for-physiotherapy were not physically verified from hard copies nor were the physiotherapy and anatomy experiences confirmed from third parties because it would have been logistically difficult to verify.

Lastly, like all epistemological theories, the radical constructivism theory has its own criticisms. Radical constructivism fully endorses a nominal ontology of Burrell and Morgan (Burrell & Morgan, 1979) and does not seek to construct knowledge that is a true reflection of the external world because it is from an interpretive paradigm. As a result, radical constructivism has been accused of solipsism, where thoughts that are disconnected from the external world are cherished (Martínez-Delgado, 2002; Quale, 2007; Riegler, 2001). The solipsism charge is weakened by anchoring of constructed knowledge in radical constructivism in real experiences and that it is not easy to fully understand phenomenon in the external world (Glasersfeld, 1990, 2001). The following Findings Chapter represents the results of the study and does not include any analysis based on literature or theoretical frameworks, which will be in the Discussion Chapter.

3.8 Conclusion of the Research Design

The research design for the thesis has been carefully described and considered the critical ontological, epistemological and the methodological issues. An extensive search was made to find high calibre participants who were anatomy lecturers and registered physiotherapists and involved an internet-based search, snowballing stage and a pre-interview survey stage. The research data was meticulously analysed using a constructivist version of the grounded methodology and care was taken to minimise my personal opinions from unduly influencing the research analysis. The next Findings Chapter will describe what emerged from the data analysis.

4 Findings Chapter

4.1 The purposes of the Findings Chapter

The main purpose of the Findings Chapter is to describe evidence from the research participants that will be analysed to contribute towards the main aim of the study of describing a pedagogical theory for guiding the teaching of anatomy for physiotherapy. The descriptions of evidence will be buttressed by 142 quotations drawn from all the interview transcripts.

The Findings Chapter will be arranged in the following sequence:

i. Contextual information: the mini-case profiles of the eight anatomy-teachers-for physiotherapy, the profiles of the participating universities, profiles of the physiotherapy students at the respective universities and the arrangement of modules within the BSc physiotherapy programmes mentioned by the anatomy-teachers-for physiotherapy in describing teaching anatomy.
ii. The pedagogical backdrop for the different Pedagogical Approaches used by anatomy-teachers-for physiotherapy.
iii. Three types of Pedagogical Approaches used by anatomy-teachers-for physiotherapy: Visual Anatomical Imagery, Kinaesthetic Anatomical Skills and the Clinical Application of Anatomical Knowledge
iv. Pedagogical Timings: When the various types of Pedagogical Approaches were used during the BSc Physiotherapy programme.
v. A conclusion for the Findings Chapter

4.2 Contextual information of the anatomy teachers and their universities

4.2.1 Descriptions of the eight anatomy teachers and their universities

Eight anatomy teachers were interviewed, males and females were in equal numbers. TABLE 9 below provides the gender, job title, Higher Education Academy standings, type of interview conducted, country of employment and the type of university for each of the anatomy-teachers-for physiotherapy who participated in the study. In addition, the founding year of each university and BSc Physiotherapy programme is indicated. Nathan was entered twice because he changed universities employing him during the interviewing stage. Pseudonyms were used to help preserve the anonymity of the participants and their respective universities. The choice of the pseudonyms for the universities denoted the type of university and had four types: 19th Century universities, Russell Group universities, Plate-Glass universities (also known as modern universities) and Post-1992 universities.

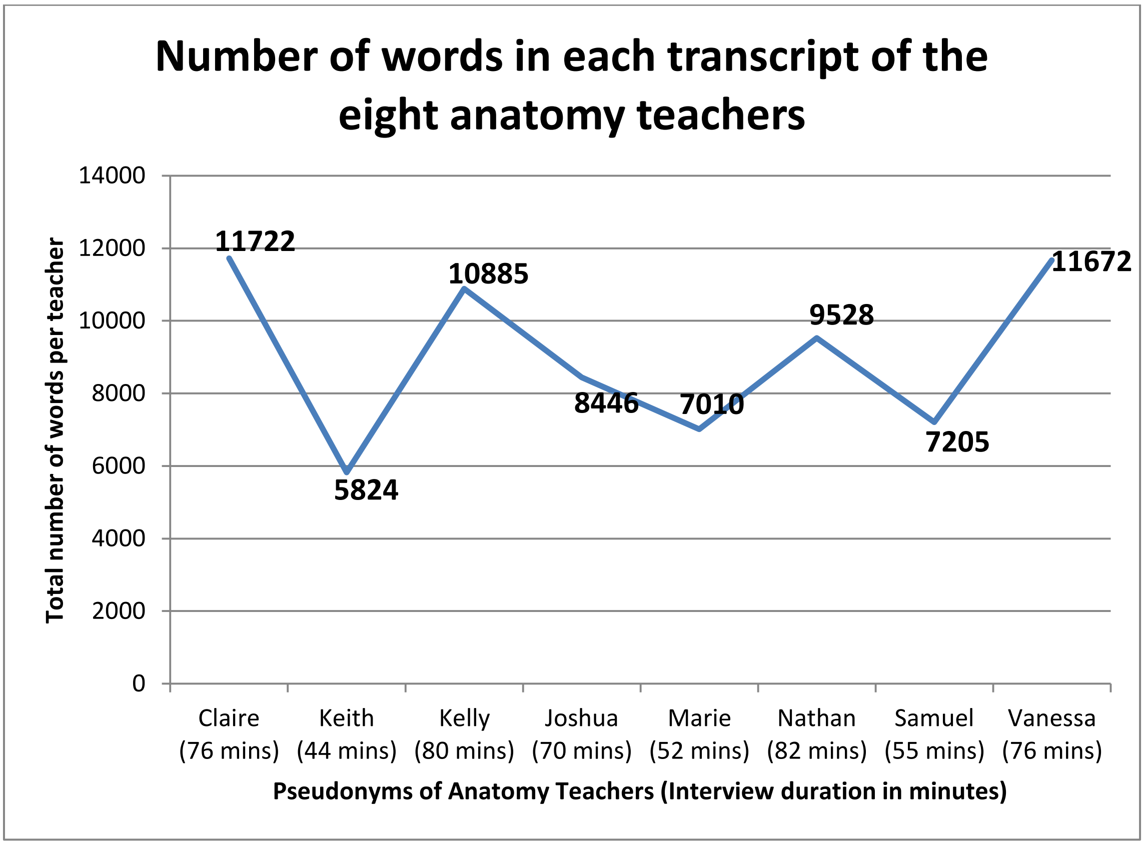
Table 9: Demographic summary of the participants

Pseudonyms of Anatomy Teachers (Gender)	Job Title (HEA standing)	Interview Location (Country of employment)	Type of university	Pseudonyms of the universities	Founding year of the university	Founding year of the BSc Physiotherapy degree
Claire (female)	Lecturer (Fellow of HEA)	Visited university (England)	Russell Group university	Russell-A University	Late 1940s	Early 1990s
Joshua (male)	Associate Professor (Fellow of HEA)	Visited university (England)	19th century university	19th Century University	Could not be found	Could not be found
Keith (Male)	Lecturer (Fellow of HEA)	Skype Interview (Scotland)	Post-1992 university	Post-1992-C University	Late Mid 2000s	#Mid 1980s
Kelly (female)	Lecturer (Fellow of HEA)	Visited university (England)	Plate-glass university	Plate-glass-A University	Early 1960s	Early 1990s
Marie (female)	Teaching Associate (none)	Visited university (England)	Russell Group university	Russell-B University	Early 1900s	Mid 1990s
Nathan* (male)	Senior Lecturer (Fellow of HEA)	Visited university (England)	Post-1992 university	Post-1992-A University	Mid 2000s	Early 2010s
Nathan* (male)	Senior Lecturer (Fellow of HEA)	Visited university (England)	Post-1992 university	Post-1992-B University	Early 1990s	Mid 2000s
Samuel (male)	Lecturer (Fellow of HEA)	Skype Interview (England)	Plate-glass university	Plate-glass-B University	Mid 1960s	Early 1990s
Vanessa (female)	Lecturer (Fellow of HEA)	Visited university (England)	Russell Group university	Russell-A University	Late 1940s	Early 1990s

 # The BSc Physiotherapy degree was awarded by a college that was absorbed by the university
**Nathan was only interviewed once*

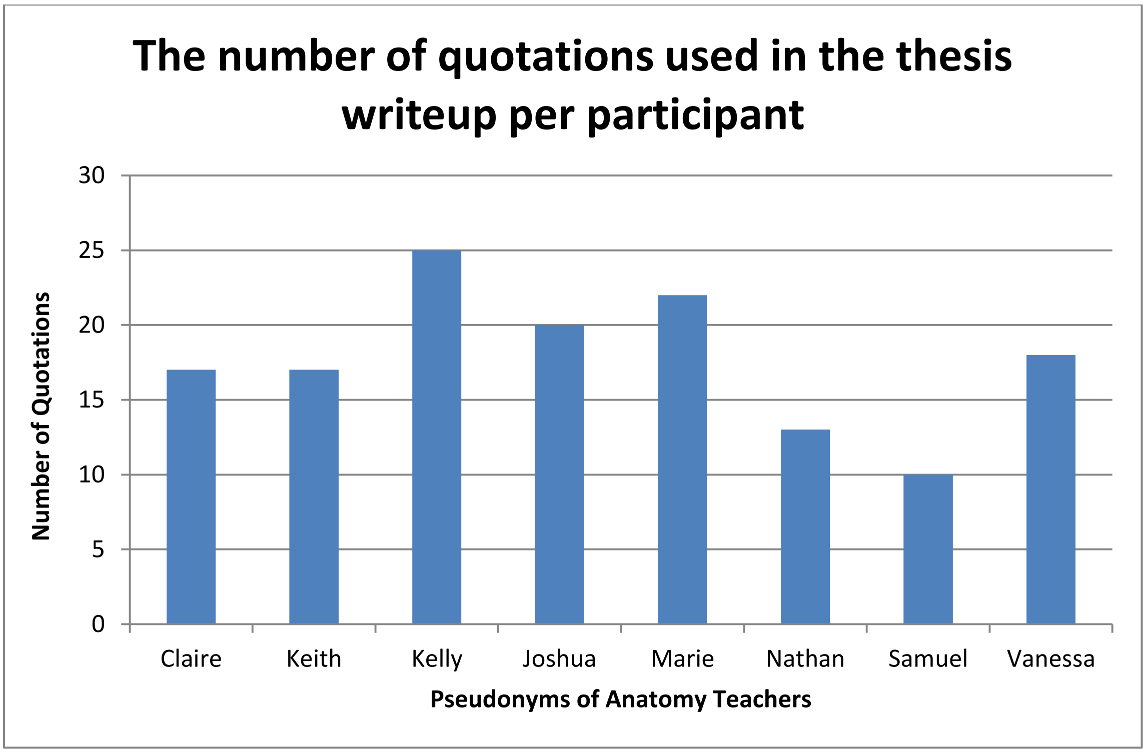
The interviews with the eight participants generated eight transcripts with a combined total of 72,292 words. The numbers of words that were produced from each interview transcript are shown in GRAPH 2 below and are arranged alphabetically.

Graph 2: Number of words in each transcript of the eight anatomy teachers



GRAPH 3 below indicates the number of quotations that each participant contributed towards the 142 quotations presented in this Findings Chapter and the totals are listed alphabetically.

Graph 3: The number of quotations used in the thesis write-up per participant



A list was compiled of the most frequently used words using an online frequency counter (WriteWords-team, 2016) in the aggregated transcript document, containing all the eight transcripts, and is presented in APPENDIX 14 on page 245. Commonly used grammatical words, like ‘the’, ’and’ and ‘that’, were removed from the list and only words appearing more than ten times were listed. There was a greater emphasis on words (highlighted in orange) associated with movement and the musculoskeletal anatomy at the expense of anatomical knowledge of the other body systems, such as the digestive system and reproductive system. The quotation below typifies that view:

> ‘Our understanding of anatomy, movement and biomechanics, and how those fit together is our standout skill set, and that makes us differ from a nurse or occupational therapist” (Claire)

4.2.1.1 Mini-case profiles of the eight participants

4.2.1.1.1 *Claire and Vanessa of the Russell-A University*

Claire was the Course Leader for the BSc Hons Physiotherapy programme, where she taught anatomy together with Vanessa described further below. She qualified as a physiotherapist two decades ago and had completed a Sports Exercise undergraduate degree prior to that. She specialised in musculoskeletal physiotherapy and public health, and had a Masters in Physiotherapy, but not a doctorate.

Claire has been teaching anatomy for just over a decade at the same university and usually spends less than three hours of teaching anatomy per week. She achieved Fellowship with the Higher Education Academy about five years ago, in part, due to work she implemented on her students on using student peer-to-peer pressure to motivate the learning of anatomy. Claire and Joshua were the only two participants who had authored publications on anatomical pedagogy and has presented at conferences. Claire is a senior member of the teaching team and had better knowledge than Vanessa on how the entire physiotherapy course was structured and run, how the curriculum had developed over the years. In addition, she knew how the course met the learning objectives of the physiotherapy regulatory bodies and how a labyrinth of learning objectives were spread throughout the course. Consequently because of her curricular expertise, she is an external examiner for other physiotherapy programmes in the UK.

The CSP requires all physiotherapy schools to have an educational philosophy underpinning its curriculum in its Programme Specification (CSP-Accreditation-Supplement, 2016; CSP-Learning-Principles-for-Accreditation, 2011). Although Russell-A University has no educational philosophies mentioned in its BSc Physiotherapy Programme Specification, there was a significant emphasis placed on peer-to-peer learning and student-centred learning.

Vanessa was a Physiotherapy Lecturer who worked with Claire at Russell-A University and was one of the first graduates from Plate-Glass-A University about twenty years ago. She has a PhD for work on how the musculoskeletal anatomy functions and her research strengths lay in movement analysis and biomechanics. She had a strong research thrust, had secured a significant research grant for her research and has over twelve journal papers on anatomical biomechanics and rehabilitation.

Vanessa had actually first learnt anatomy when she was studying for her first year courses of a medical degree, but did not proceed to the second year. She found medical anatomy more factual and was relatively more poorly linked to clinical use than learning anatomy for physiotherapy. Vanessa had not been practising physiotherapy for the last seven years, although she has maintained her physiotherapist registration with the HCPC. She was the 1st Year Lead for all the 1st year Physiotherapy modules, which had all the formal anatomy tutorial teaching. She has been teaching anatomy for five years at the current university and has no journal publication on pure anatomy or anatomical pedagogy. She teaches anatomy between three and ten hours per week and achieved Fellowship with the Higher Education Academy about three years ago (Bithell, 2007).

4.2.1.1.2 Keith of the Post-1992-C University

Keith was a Physiotherapy Lecturer who qualified as a physiotherapist about 20 years ago in Australia and migrated to the UK. He specialised in musculoskeletal physiotherapy and graduated with a MSc in Manual Therapy about ten years later. Keith has been teaching anatomy for about a decade and teaches anatomy for about three to ten hours per week during the busiest of times, but has no journal publications and had not given any conference presentations on anatomy or anatomical pedagogy. He has been a Fellow of the Higher Education Academy for over five years.

The physiotherapy school of the Post-1992-C University commended adult learning (andragogy) and peer-to-peer learning to develop reflective thinking in the Programme Specification. Case-based scenarios and real learning environments were used to develop student autonomy. The Post-1992-C University was the only one of the assessed universities that has a four year fulltime BSc Hons Physiotherapy degree because it was based in Scotland, where all undergraduate degrees are four years of full-time study.

4.2.1.1.3 Kelly of the Plate-Glass-A University

Kelly was a Physiotherapy Lecturer who became a physiotherapist about 35 years ago and still practices physiotherapy. She achieved neuromusculoskeletal physiotherapy specialisation accreditation about ten years ago and has a Masters in Physiotherapy, but not a doctorate. Kelly was granted fellowship with the Higher Education Academy between 5-10 years ago. Kelly spends between three and ten hours per week teaching anatomy. She is a senior teacher who has significant power and was responsible for leading and managing the teaching of anatomy in lectures and tutorials, organising cadaveric specimens for teaching and teaching anatomy in clinical student placements across the undergraduate and postgraduate physiotherapy degree programmes. The physiotherapy degree programme at her university was started in the mid-1990s and Kelly was one of the first teachers of physiotherapy to be recruited and has taught there ever since then. There was no explicit reference to any known education philosophy in the Programme Specification, but extolled reflective students working autonomously.

4.2.1.1.4 *Joshua of the 19th Century University*

Joshua was an Associate Professor who graduated and qualified as a physiotherapist in Australia about 25 years ago, and is still practising across a wide range of physiotherapy areas, such as respiratory physiotherapy, musculoskeletal physiotherapy and neurological physiotherapy in both hospital and private practices. Ten years after graduation, he completed a Masters in Musculoskeletal Physiotherapy and immediately joined the current university, where he teaches anatomy for less than three hours a week at most.

Joshua completed his Doctorate in Education less than five years ago and his research interests lie in pedagogical practices within the physiotherapy schools, like peer-to-peer learning, reflective thinking among students and gender ramifications on physiotherapy learning. He had the highest teaching standing among all the participants and is a Senior Fellow of the Higher Education Academy. He has journal publications and has given conference presentations on anatomical pedagogy.

4.2.1.1.5 *Marie of the Russell-B University*

Marie was a Physiotherapy Teaching Associate who graduated and qualified as a physiotherapist about 15 years ago and is still practising physiotherapy part-time. She has a master's degree and is currently studying towards her PhD on the effects of exercise on neurological conditions. Her strongest physiotherapy expertise was on neurological physiotherapy and she is in a leadership position within the Association of Chartered Physiotherapists in Neurology. Marie has been teaching anatomy at the same university for close to a decade and at most teaches up to three hours per week. She has not achieved Fellowship with the Higher Education Academy and does not have publications on anatomy or anatomical pedagogy.

4.2.1.1.6 *Nathan of the Post-1992-A University and Post-1992-B University*

Nathan was a Senior Lecturer who has been practising clinical physiotherapy since his graduation across a number of physiotherapy specialties. He has a specialist qualification in musculoskeletal physiotherapy and has been practising physiotherapy at his private physiotherapy practice for over ten years. Nathan had the strongest set of degree level qualifications and training in anatomy amongst all the participants and he had graduated with a BSc in Anatomical Sciences immediately before starting his BSc Hons Physiotherapy degree. Nathan's Phd degree had a strong anatomical component and was completed over five years ago. Nathan has been teaching anatomy for over a decade and is a Fellow of the Higher

Education Academy. He has a light anatomy teaching load of less than three hours a week. He has no journal publications on anatomical pedagogy, although he has a number of journal publications on clinical anatomy related to physiotherapy.

Nathan has just changed the university that employed him and moved from Post-1992-B University to Post-92-A University. The Post-1992-A University introduced the physiotherapy undergraduate degree less than five years ago and has been cautious by admitting about 20 students per year. The initial registration of the BSc Physiotherapy degree was delayed because the Post-1992-A University had not submitted its educational philosophy. The Programme Specification was based on constructivist learning, transformative learning and a spiral curriculum with progressively increasing complexity. The Programme Specification of the physiotherapy degree at Nathan's previous university (Post-1992-B university) was based on the Problem-Based Learning (PBL) pedagogical philosophy aimed at developing problem solving skills and autonomy, and teaching activities used clinical situations or scenarios based on the most common clinical situations.

4.2.1.1.7 Samuel of the Plate-Glass-B University

Samuel was a Physiotherapy Lecturer who qualified as a physiotherapist about 30 years ago. He practiced clinically for the first 15 years on an area of musculoskeletal physiotherapy called rheumatology (diseases of inflamed joints, such as rheumatoid arthritis and osteoarthritis). He successfully defended his PhD in Rheumatology between 5-10 years ago.

Samuel taught between three and ten hours per week of anatomy at the busiest of times. He was unusual among all the participants in that he had published an anatomy textbook that is now in its third edition and had also written other physiotherapy textbooks. He was twice awarded the best teacher of the year at his university for teaching anatomy. He is a visiting anatomy lecturer and external examiner to other universities. He has journal publications on anatomy, but not on anatomical pedagogy.

4.2.1.1.8 Summary of the mini-cases

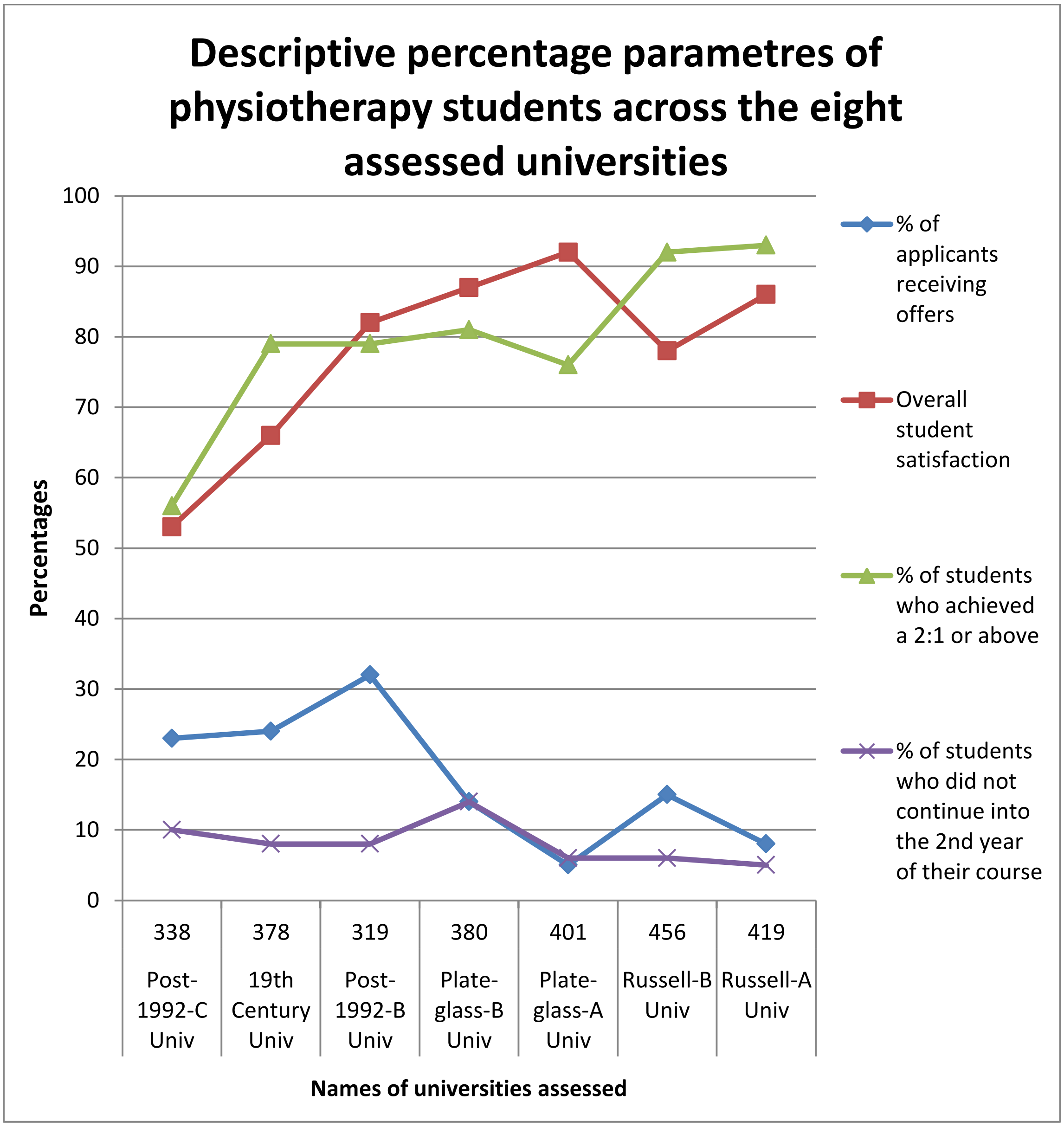
All the anatomy-teachers-for-physiotherapy who participated were highly experienced and qualified physiotherapists. Seven anatomy-teachers-for-physiotherapy were musculoskeletal specialists, while seven had fellowship with the Higher Education Academy. Seven out of eight universities started their BSc Physiotherapy programmes on or after 1992 and this appears to coincide with when the BSc Physiotherapy degree became the minimum entry-level qualification across the United Kingdom in 1992 (Barclay, 1994; Bithell, 2007). The Programme Specifications of the five schools were obtained and some of them advocated for student-centred learning, autonomous learning and reflective thinking that could be traced back to

(HCPC-Training-Standards, 2009) and CSP (CSP-Learning-Principles-for-Accreditation, 2011) guidelines, but not constructivist learning, spiral learning, transformative learning, peer learning and andragogy.

4.2.2 Profiles of BSc Physiotherapy students across the eight universities

The levels of student satisfactions, percentage of students attaining at least a 2.1 degree classification, student dropout rates among the 1st year students and the percentages of students accepting offers were rounded off to the nearest 5% to preserve anonymity, and are shown in GRAPH 4 below.

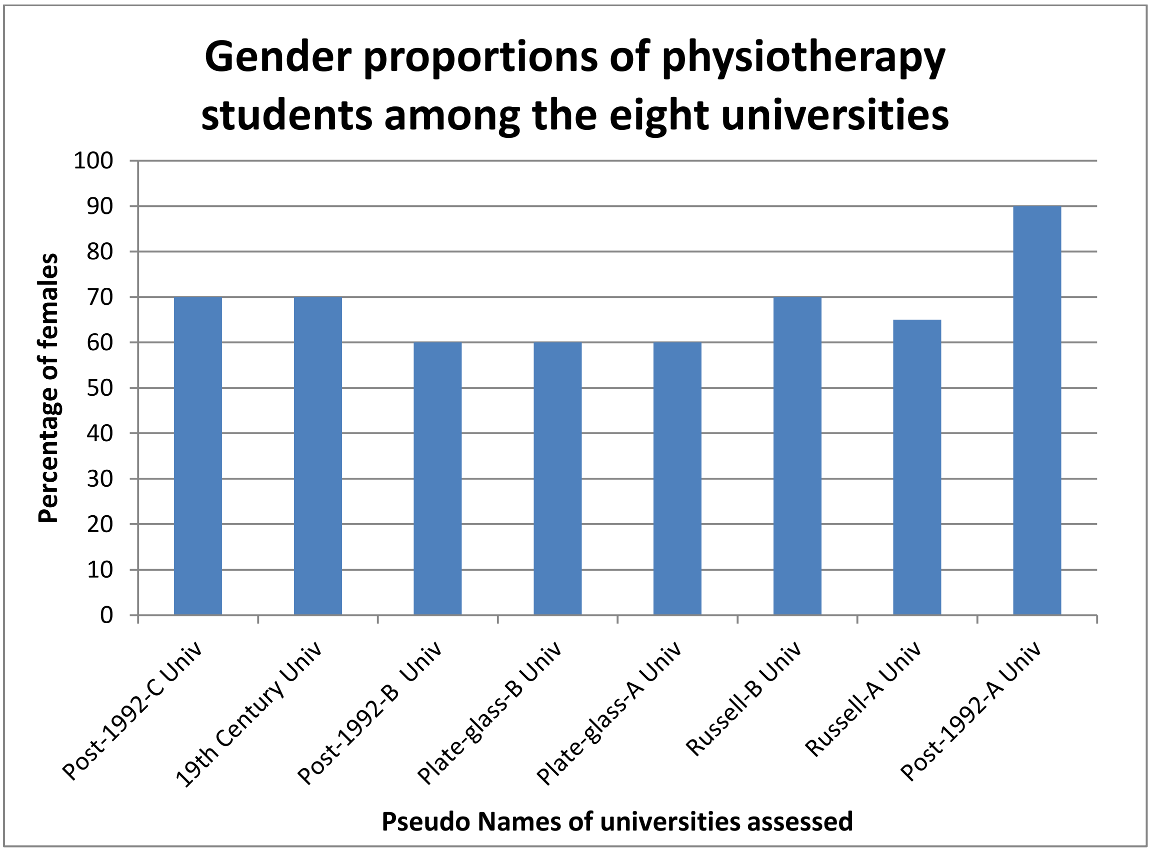
Graph 4: Descriptive percentage parameters of physiotherapy students across the eight assessed universities



The seven universities fell into two groups. The first group of Post-1992-C University, 19th Century University and Post-1992-B University were less selective of new students, who in turn, had a higher attrition rate of 1st year students, lower percentage of students attaining at least a 2.1 degree classification and consequently lower overall student satisfactions than the other four universities. The eighth university was not represented because it recently started the BSc Physiotherapy degree programme and did not have all the data.

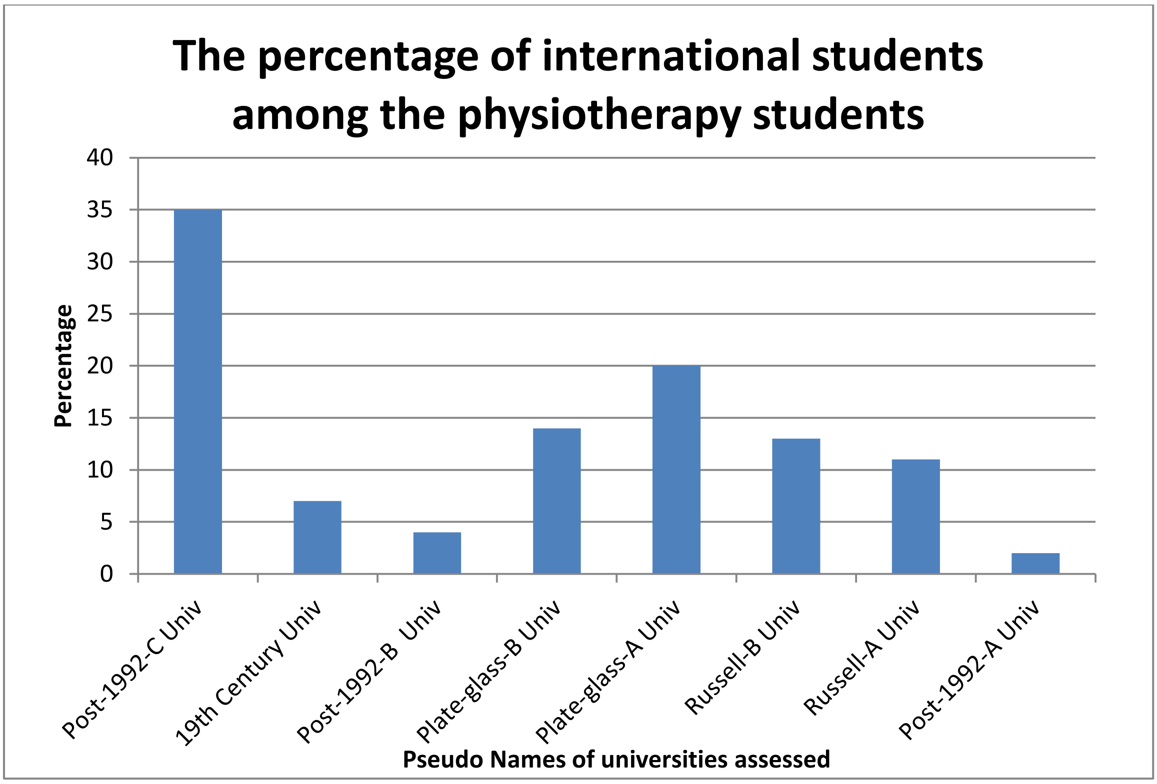
The gender compositions of physiotherapy students across all the eight universities were consistently dominated by females, as shown in GRAPH 5 below. Post-1992-A University had the highest percentage of females (90%), while three universities had the lowest percentage of 60%.

Graph 5: Gender proportions of physiotherapy students among the eight universities



There was a significant proportion of international students among the physiotherapy students and may have an influence on how anatomy is taught. The Post-92-C University had the highest proportion of international students of 35%, while the lowest percentage was 2% at the newly established Post-92-A University, as shown in GRAPH 6 below.

Graph 6: The percentage of international students among the physiotherapy students



4.2.3 Descriptions of BSc Physiotherapy modules mentioned during the interviews

There were several modules that were frequently mentioned in the interview transcripts which could be grouped into five modules with pseudonyms describing the content within them, and are listed in APPENDIX 15 on page 246. The pseudonyms for the five modules are:

i. Anatomy and Function Module
ii. Musculoskeletal Physiotherapy Module
iii. Cardiorespiratory Physiotherapy Module
iv. Neurological Physiotherapy Module
v. Physiotherapy Management of the Complex Patient Module

The 'Anatomy and Function Module' was typically a 1st year course at level 4 of the framework for higher education qualifications in England, Wales and Northern Ireland (FHEQ) (Quality-Assurance-Agency-for-Higher-Education, 2008). The Practical Anatomy Tutorials formed the greater bulk of teaching sessions for anatomy in the 'Anatomy and Function Modules'. The Musculoskeletal Physiotherapy, Cardiorespiratory Physiotherapy and Neurological

Physiotherapy modules were the main fields of physiotherapy taught and were typically 2nd year modules at level 5 of the FHEQ. The ‘Physiotherapy Management of the Complex Patient’ module, a 3rd year module, involved teaching knowledge on the three major specialties of physiotherapy patients with more challenging conditions being taught at higher cognitive level 6 of the FHEQ.

4.3 Pedagogical Backdrop

There were a number of pedagogical issues that were in the background of the three Pedagogical Approaches that will be described from page 87. There was a huge volume of anatomical content that had to be taught in very limited timeframes in an era where there was a generational change on how anatomy for physiotherapy was taught. Physiotherapy students quickly forgot anatomical knowledge and the anatomy-teachers-for-physiotherapy frequently revisited and reinforced the same content to help the students to remember.

4.3.1 Large quantity of anatomical content to be learnt

There was a common thread among all the participants that the anatomical knowledge that the undergraduate physiotherapy students had to learn was voluminous. The following quotations from two different anatomy teachers capture the feeling that there was an enormous anatomical content that physiotherapy students had to learn.

> "There is a lot knowledge-based content, so there are a lot of things to remember" (Keith)
>
> "I think that you know yourself that when you are learning anatomy, there is a lot that you need to learn in terms of the quantity of things" (Marie)

The main strategy used by anatomy teachers to reduce the volume of anatomical knowledge to be learnt by students was to focus on teaching the most essential and core anatomical knowledge relevant for physiotherapy practice, which will be described later in Section 4.5.2.2 on page 104.

Part of the bulkiness of the anatomical knowledge to be learnt was because anatomy has an extensive vocabulary that has to be mastered and the two quotations below portray the sediments of six of the eight participants.

> "It's a whole new language" (Kelly)
>
> "I think some people find anatomy to be threatening because of the language and words … I think it is very daunting" (Samuel)

4.3.2 Insufficient curricular time for anatomy

The opportunity for physiotherapy students to learn the voluminous anatomical knowledge was compounded by a common problem among all the anatomy teachers that they were given insufficient time to teach anatomy in their timetables, and quotations below encapsulates their concerns.

"In the 1st year, there is an awful lot, there is much to do and in so little time, that is just too much" (Kelly)"

"Time is always pressured, there is a lot to fit in the time that you have" (Marie)

The insufficient timetabled time was said by two participants to be caused by senior physiotherapy academics systemically pruning and reducing available teaching time for anatomy over the years and decades, as highlighted by the following two quotations:

"I think with my experience in higher education, which is about ten years, there is ongoing pressure of reducing contact (time with the students) and face-to-face contact" (Keith)

"I think these students probably get ten weeks less contact time than what I had when I was a student, if not more" (Claire)

4.3.3 Generational changes in teaching anatomy for physiotherapy

The way anatomy was taught had changed over the last couple of decades from didactic, teacher-centred and lecture-based teaching to student-centred, tutorial-based teaching, where anatomical knowledge is integrated with other relevant disciplines. Joshua summarises the change sediment felt by six of the participants:

"I think in the past it (anatomy teaching for physiotherapy) has been didactic" (Joshua)

Anatomy teachers have moved away from heavy use of lecture-based teaching to extensive use of student focused and tutorial-based teaching, as indicated in the yet to come Section 4.5.2 on page 103.

There was abundant evidence from all the interviews in support of early integration of anatomical knowledge with physiotherapy treatment knowledge, in contrast to the past where anatomical knowledge was taught during the first year without relevance to physiotherapy and the clinical application during the 2nd and 3rd years:

"We are now trying to do things differently, we are trying to integrate it (anatomical) a bit more, so that the anatomy is not a pre-cursor" (Joshua)

Although the anatomy modules in the current study were typically taught during the 1st year as precursors for the 2nd and 3rd year clinical modules of physiotherapy, as shown in Appendix 15 on page 246, the anatomy modules had an inherent clinical application within them.

4.3.4 The temporality of anatomical knowledge

Anatomical knowledge was seen by all participants as transient and diminishing when not being used or reinforced, as exemplified by the following quotation.

> "If you ask me to learn French around a particular interaction and then didn't have me in that situation for a year, and then said to me 'Do you remember, we talked about this, uumm, we did this in Week 6 and now it's Week 42! Why can't you remember these words'. I will kind of go 'I can't remember', so I think that's fine" (Kelly)

Knowledge decay caused gaps in knowledge and the gaps in knowledge in students were seen as normal by all the participants.

> "We all got gaps (in knowledge) and the (knowledge) gaps get bigger with time and some close" (Joshua)

4.3.5 "Reinforcing" anatomical knowledge through the three Thematic Reinforcement concepts

All the anatomy teachers used teaching activities that repeatedly revitalised and reinforced similar anatomical knowledge, as exemplified by:

> "I think we need repetition, repetition is not often enough, that's how I look at it" (Kelly)"

The terms 'reinforcement' and 'reinforce' were mentioned 12 and 11 times respectively, as indicated in Appendix 14 on page 245, and indicate a sense of making the knowledge more robust and stronger with each revisitation.

The squirrel nut analogue emerged from the coding process and helps to explain how temporality and reinforcement of anatomical knowledge were related. The squirrel forages for nuts (anatomical knowledge) from different parts of the forest (different learning environments usually created by anatomy teachers) and places the discovered nuts (anatomical knowledge) into a squirrel nut bag (the memory of the student). The nuts in the squirrel bag decayed and disappeared if they were not revisited and reinforced and required the nuts to be pulled out of the squirrel bag (recalled from memory) and checked for integrity. The process of repairing decayed nuts with reinforcement (by adding minor elements which would have been forgotten) or disappeared nuts with restoration (relearning completely) ensured viable nuts (useful anatomical knowledge) in the squirrel bag.

4.4 The Pedagogical Approaches

The three Pedagogical Approaches were the Visual Anatomical Imagery, Kinaesthetic Anatomical Skills and application of anatomical knowledge in treating patients. Each of the three Pedagogical Approaches had repertory and clinical applicatory themes within them. All the three Pedagogical Approaches provided numerous opportunities for the repetition of anatomical knowledge or applying the anatomical knowledge and/or skills to situations that mimicked or assisted the physiotherapy treatment of patients.

4.4.1 Visual Anatomical Imagery concept

There was a strong and consistent visual theme in the teaching and learning anatomy for physiotherapy in all the physiotherapy schools. Highly visual anatomical learning aids were thought to stimulate more efficient learning outcomes of anatomical knowledge among physiotherapy students and were explicitly mentioned by seven out of eight anatomy teachers, as portrayed by:

> I think that anatomy is one of those things that you learn better if you can visualise and see it on a patient" (Claire)

4.4.1.1 Rational for using Visual Anatomical Imagery

Many reasons were offered for the utilisation of the Visual Anatomical Imagery concept in teaching anatomical knowledge. Four of the teachers preferred to teach using Visual Anatomical Imagery because they were naturally visual learners themselves,

> "I am a visual learner, so my teaching is very visual" (Samuel).
>
> "I am very visual. When I close my eyes, I can start to imagine what layers, and how they might go from the surface (of the skin) to the deep" (Joshua)
>
> "And that's probably very influenced by how you learn yourself, isn't it, I mean I am a very visual learner and I need to see things and experience things for it to sink in and remember it so that tends to be the way I end up teaching because I can't remember" (Vanessa)
>
> "I think if I just read something, I just won't take it all in. I think I will get all confused, it's so much text. I can read for short period and digest, but I find visualisation easier" (Nathan)

One participant attributed the Visual Anatomical Imagery to that anatomical sciences are inherently very visual:

> "Obviously, anatomy is a very visual thing" (Samuel).

Another participant felt that both the students and the physiotherapy profession were both visually inclined,

> "Most students are visual and kinaesthetic and that aligns very nicely with the profession of physiotherapy" (Keith)

Another participant preferred using visual imagery because learning anatomical knowledge using Visual Anatomical Imagery was more time efficient and quicker:

> "(I started using visual imagery teaching methods) only when I had to learn a lot of information in a very short space of time. I discovered that was for me the quickest way to do it" (Claire).

4.4.1.2 Examples of Visual Anatomical Imagery

4.4.1.2.1 Visual imagery in books

Six anatomy teachers preferred certain anatomy textbooks for their students (that are listed in APPENDIX 16 on page 248 and the books in bold were the most highly praised), in part, because they had great visual diagrams, illustrations and photographs, as demonstrated by the following couple of quotations from three separate participants:

> "I mean they (the images) are beautiful, from a purely anatomy view you think wow!" (Kelly)
>
> "I think the quality of images (in a good anatomy book) is very important" (Keith)
>
> "I use lots of images in my teaching, I particularly like the (book) resources by David Neumann ..., and has lovely imaging showing the anatomy moving, what happens to the anatomy during movement ... His book is very visual, there are very beautiful illustrations in there" (Claire)

All the anatomy books listed in APPENDIX 16 were purchased by the researcher, except the book by Neumann, to confirm the use of Visual Anatomical Imagery and are shown in FIGURE 10 on the next page. The book by Netter was obtained as an electronic version.

Figure 10: Anatomy books that were highly regarded visually by anatomy teachers

4.4.1.2.2 Anatomical Sketching
Simple sketching of anatomical structures was another way used to develop Visual Anatomical Imagery in students and was mentioned by three anatomy teachers, and is exemplified by the following discussion:

> Nathan: I always say to my students, this is how I kind of learn my anatomy, I actually did lots of drawings … after the lecture I would go home and learn anatomy just by drawing pictures, I would find pictures … so if I draw it, I always say 'Go home and draw these things, then visualize, then you can at least tell what they are and later on yourselves as well'
>
> Researcher: So when they are drawing, are they drawing a perfect picture or a sketch drawing?
>
> Nathan: No, a sketch drawing, yeah it's not like an artist's drawing

Some of the drawings were actually on the students themselves to show what anatomical structures were underlying the skin.

> "I think drawing can be a good way of learning. When the students draw on each other and on a piece of paper drawing the structure and trying to remember them that way" (Keith)

Perhaps the most elaborate, sophisticated and well-polished anatomical diagrams were those drawn by Samuel.

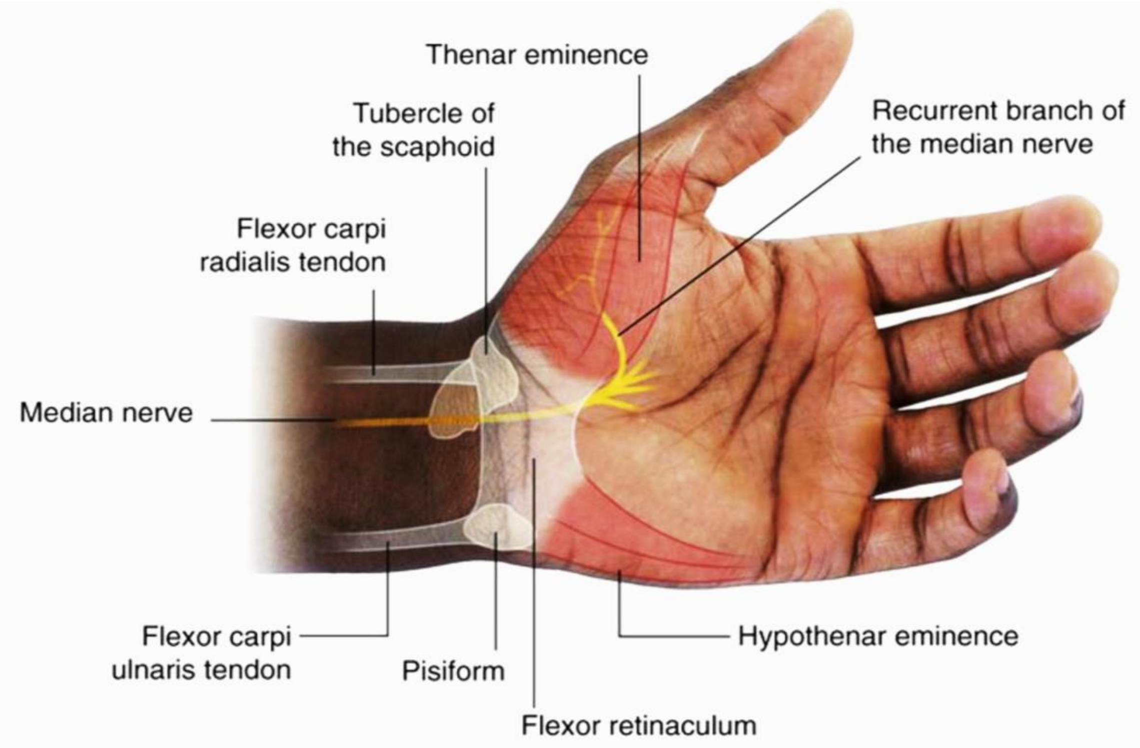
> "I make lots of (anatomical) diagrams ... some 20 years' worth and probably the easiest thing to do is to look at my Twitter and YouTube account, and there will be some anatomy stuff I have done there and that might give you an idea" (Samuel)

Samuel published his anatomy diagrams in an anatomy textbook for physiotherapy students, which is now in its third edition.

4.4.1.2.3 Three dimensional anatomical imagery
Half of the participants liked Visual Anatomical Imagery that promoted the three-dimensional (3D) imagery of anatomical structures lying beneath the skin of patients and encouraged the

> "imagining things (anatomical structures) in three-dimensions" (Joshua)
>
> "The three-dimensional imagination of things was previously aided by students learning anatomy in the dissection room, and through pictures, photographs, and textbooks. Whereas now, you have got three-dimensional models (in anatomical software) that you can rotate, you can twist and computer generated images that students can strip off layers to go deeper and shallower, and kind of get a sense of that (3D) imagery, now that is very helpful" (Joshua).

Figure 11: An illustration of three dimensional imagining of anatomical structures deep to the skin



The image is from Drake, Vogl, & Mitchell, 2010.

Part of 'imagining things in three-dimensions' was understanding the relationships between the anatomical structures and how they are intertwined:

> "What has been important to me about the anatomy and understanding the 3D nature of it is the interconnections between things, how they relate to each other" (Joshua)

4.4.1.2.4 <u>Learning aids to promote Visual Anatomical Imagery</u>

A wide range of learning aids was used to teach 3D anatomical imagery and included prosected cadaveric specimens, ultrasonographic equipment, anatomical software and simple self-made models. Prosected cadaveric specimens were used by all but one of the anatomy teachers to promote Visual Anatomical Imagery.

> "I had learned my anatomy using cadavers, yeah, I think so, I think it's really useful to see exactly where things are. So I think that should help visualise a living person." (Nathan)

Another participant used an ultrasound machine that sends sound waves into the body and analyses the sound echoes to reconstruct how anatomical structures are arranged. He said that:

> "We use ultrasound as well, where we get the machines to visualise different structures, like bone, bony contours, muscle tendons, nerves, blood vessels in vivo" (Keith)

Some participants used anatomical software, often purchased at a great expense to stimulate Visual Anatomical Imagery in students, as highlighted below:

> "The university bought a (visual anatomy software) package called 'Anatomy TV' ..., it is a very expensive package. So the students have good access and a very lovely resource that students use" (Claire)

Half of the teachers also used simple self-made anatomical learning aids to visually explain some anatomical concepts.

> "During the functional anatomy practicals I will kind of, when discussing a muscle, I will try mark it out with a bit of theraband, sort of something visual, this muscle is from here to here. So therefore when the muscle shortens it will kind of produce this movement" (Nathan)

4.4.1.3 Limitations of the Visual Anatomical Imagery concept

The Visual Anatomical Imagery concept had its limitations. Some students could not "visualise" anatomical structures lying further beneath the visible anatomical structures and alternatives might be needed.

> "They always struggle with figuring out what origin and insertion of these muscles are, especially deeper structures that they can't see, I think they find that difficult to visualize." (Nathan)

> "Some actually don't use the 3D kind of way of thinking about it, but look at remembering things by mind maps or other things" (Joshua)

4.4.2 Kinaesthetic Anatomical Skills concept

The Visual Anatomical Imagery was typically seen as an essential preliminary phase for Kinaesthetic Anatomical Skills.

> "So we follow the visual thing with the kinaesthetic learning of that particular anatomy" (Claire)

The Kinaesthetic Anatomical Skills were physiotherapy skills that used factual anatomical knowledge, Visual Anatomical Imagery, being able to palpate anatomical structures beneath the skin with confidence, understanding how the anatomical structures feel and look like when they are moved and analytic and problem solving skills. These Kinaesthetic Anatomical Skills were built through practical experiences, rather than through reading only:

> "So it is a much more visual and experimental learning of anatomy, rather than going to a textbook" (Claire)

Kinaesthetic Anatomical Skills involved palpations and hand manipulations that were heavily dependent on anatomical knowledge that physiotherapy students were expected to learn. Palpation is a technique of feeling of anatomical structures under the skin with fingers of hands and the identification of anatomical structures based the texture, flexibility, response to different movement and location of the structures.

> "I think the other thing is that palpation of muscles, I think, the students find it hard as well, because e.g. when you 'google' forearm muscles, it will give you pictures of all the different muscles, but when you look at the forearm you just see skin and you ask yourself where is that muscle? There is a few tendons, that and that one. And palpation is quite tricky as well" (Nathan)

4.4.2.1 Rational for using Kinaesthetic Anatomical Skills

Most of the participants attributed the reason for using Kinaesthetic Anatomical Skills to promote effective learning of anatomy to the extensive use of hands within the physiotherapy profession, as justified by the following quotation from a participant.

> "Our profession (physiotherapy) is a very hands on profession" (Keith)

4.4.2.2 Examples of Kinaesthetic Anatomical Skills

All of the anatomy teachers created kinaesthetic rich anatomical learning environments for their students. Kinaesthetic Anatomical Skills were learnt when students interacted with artificial anatomical structures of plastic or man-made models or real anatomical structures on healthy people or patients.

Probably the first kinaesthetic anatomical learning resource that students were given was a complete set of plastic human bones at the start of the 1st year. Most the physiotherapy departments, which formed part of this study, loaned each and every physiotherapy student a set of plastic life sized skeletons, as exemplified by the following quotation:

> "The students are actually given a set of bones at the beginning of the year. They pay a deposit and return them at the end of the year" (Joshua)

> "They rent a skeleton in their first year, so they pay about £40, I think, and they rent a skeleton for the year. So they get them in box. ... So over the years we have about 60 boxes of skeletons." (Vanessa)

The following quotation exemplifies how skeletons were used during the practical tutorials:

> "We would expect them to bring the bones in (to classes), then if we are talking about joints we would bring the bones and fix them together using BlueTack … put the muscles on the skeleton and look at them, how it's pulling and how the lever works"(Vanessa)
>
> "I encourage the students to use the skeleton and to get pieces of elastic, pieces of string and Blutack, and they build ligaments onto the skeleton, and they see what happens when they bend the knee and see what happens to the ligaments when they bend the knee" (Claire)

The ultimate kinaesthetic learning experience that all the anatomy-teachers-for-physiotherapy was usually on living humans, where the students located anatomical structures on people, as exemplified by the following two statements below:

> "When they have just started a session with simulated patients, they are doing measurements on the elbow, wrist and hand, and that's quite a nice environment, although it's quite an expensive thing to arrange in many ways because we have to normally hire about 8 simulated patients for them to work, for them to work in pairs with them. It's really nice because they take it a little bit more seriously than when assessing each other and it helps a lot with professionalism" (Vanessa)
>
> "How would you palpate that anatomy? How would you find it with your hands? The muscles, how would you make them work? How would you make them stand out?" (Claire)

FIGURE 12 below from MediStudents, 2016, illustrates the palpation of a patella (knee cap) on a student.

Figure 12: An illustration of a student palpating a patella bone on a fellow student

Nathan said that he often started with palpating himself when he was a student.

> "I also used to sort of do the muscle tests on my own or palpating certain things and actually sort of seeing how things are working. I think it makes more sense when you can see it … on a body" (Nathan)

Opportunities for the students to develop their Kinaesthetic Anatomical Skills were multiplied by asking the students to practice them on each other:

> "We very often get the students to go away and practice both individually and in pairs, performing a particular movement and how that would work or how that would come across" (Marie)

> "We also get them to working in groups, we give them a pile of resources, they have got the bones, they have got the textbooks and get them to problem solve and go through that and in terms of the materials that we provide" (Vanessa)

4.4.2.3 Limitations of using Kinaesthetic Anatomical Skills

Kinaesthetic Anatomical Skills required expensive resources to develop, such as plastic anatomical models, adjustable beds for the students to practice upon, video recording equipment ultrasonographic equipment, hiring people to be fictitious patients and the setting up and running expensive cadaveric laboratories. Only two universities of the eight, Post-1992-A University and Post-1992-B University, did not use cadaveric specimens

> Researcher: Do you frequently use cadaveric specimens (at the Post-1992-A University)?
>
> Nathan: No just models.
>
> Researcher: What about at the Post-1992-B University?
>
> Nathan: No, just models and skeleton models.

Nathan taught at both of the universities and he attributed the lack of Laboratory Cadaveric Tutorials to the significant investment costs required.

4.4.3 Application in treating patients

There was a firm thread across all the teachers of applying anatomical knowledge to a wide spectrum of physiotherapy situations as depicted by the following statement from a participant:

> "I suppose that it (anatomy) being reinforced in other (physiotherapy clinical) contexts will help the long term learning of anatomy" (Marie)
>
> "I think that's why we try to get to do this deep learning of anatomy, starting to apply and starting to think how it applies in practice because it reinforces it." (Vanessa)

The teaching of the application of anatomical knowledge to physiotherapy situations was divided into two teaching phases: teaching environments with no real patients during the 1st year followed by teaching environments with real patients during the 2nd and 3rd years.

4.4.3.1 Teaching environments without real patients

Six out of eight teachers explicitly used a pedagogical strategy of structured case-based learning or clinical mini scenarios to support the application of anatomical knowledge in physiotherapy treatments. Structured case-based learning was characterised by the use of anatomical knowledge to help understand, problem solve, assess and treat fictitious or historical clinical presentations and problems, usually within a teaching session.

> "We use clinical mini scenarios or case studies, I think they are used for students to try and contextualise the anatomical knowledge" (Keith)

The structured cases did not involve patients who had to be physically present during the teaching session, but rather the medical story of the signs, symptoms and treatments were usually extracted or drawn from previous real cases to create a thinking framework for developing anatomical knowledge in physiotherapy students. Clinical mini scenarios were:

> "live examples, (historic cases of patients) cases, maybe paper-based cases, vignettes, video ones or ... virtual patients that you can kind of relate anatomy to" (Joshua)

Some of the clinical mini scenarios were from past clinical experiences of the anatomy teachers.

> "trying to make it as applied as possible using my own kind of narratives ...I used anecdotes from my own stories. … Some of the examples are very much my own anecdotes that are used" (Joshua)

One of the early exposures of 1st year students had to clinical mini scenarios was when the students were independently reading their recommended anatomy textbooks. Many of the participants used an anatomy textbook by Keith Moore (K. Moore, Dalley, & Agur, 2013) and it was recommended, in part, because it had appropriately brief clinical mini scenarios for physiotherapy freshmen.

> "We are on Moore (i.e. we are using an anatomy textbook by Keith Moore as a recommended text) with those nice blue pages in it which gives the clinical component, which is quite nice ... because it gives short, tiny little ... scenarios" (Kelly)

1st year physiotherapy students had limited clinical physiotherapy knowledge and all of the participants were always careful to progressively increase the complexity of clinical conditions being taught. One participant was noted saying that:

> "By the time they (the students) are finished with the first semester (of 1st year), they would have rudimentary knowledge in the management of simple straight forward conditions" (Kelly)

4.4.3.2 Teaching environments with real patients

The general strategy of teaching anatomy on real patients was mentioned by all the anatomy teachers and occurred largely in student placements and clinical teaching sessions in the 2nd and 3rd years.

> "So what we are doing is embedding it (anatomy) all the time" (into 2nd and 3rd years) (Kelly)

Part of the 'embedding' anatomical knowledge into the 2nd and 3rd year clinical teaching was achieved by students being anatomically inquisitive and asking themselves how anatomy is involved in the various patients conditions they were coming across, as shown the following two quotations:

> "(It is about) putting it (the anatomical knowledge) into patient contexts saying 'okay, so you know your shoulder anatomy and what happens when they have got a subluxation (mild shoulder dislocation), what's gone wrong there and what can we do and how can we use the principles of what we learnt about the biomechanics of the joint to work on that and to improve it'" (Marie)

> "In the 2nd stage of 2nd year, we are making it more complex, 'You tell us about the anatomy that will be relevant to the patient condition and the (patient) assessment that they do. So what is the diagnostic test or clinical test? What could it tell you about the anatomy? Have you a theory of what is going on? How can this be confirmed?" (Kelly)

One participant expressed disappointment with some students with poor levels of anatomical inquisitiveness who preferred to invest the least effort in learning their anatomical knowledge.

> "I get very disappointed when you have students who literally might learn a technique and all they can say is 'Yes, I learned the technique and I did that to the extensor muscle of the knee', you are thinking, 'Okay, so just tell me what they are then?'. They go 'oh yeah, they are ...(the students become speechless)', and you get kind of fairly low level information" (Kelly)

The anatomical inquisitiveness was meant to expose their gaps in anatomical knowledge and trigger the students to restore and revitalise the gaps in knowledge and was mentioned by half of the participants.

> "They will have to find out about things they don't know in order to improve their practice throughout their careers" (Marie)

4.4.3.3 Source of the Pedagogical Approaches in general

None of the anatomy-teachers-for-physiotherapy referred to literature in justifying the use of any of the three Pedagogical Approaches in their teaching activities, as exemplified by the quotation below:

> "I don't know if people follow any particular published guidelines or any kind of journal research that has been done" (Marie)

Half of the participants claimed that their personal experiences and institutional historical experiences were the sources of the three Pedagogical Approaches, as exemplified by a couple of quotations below.

> "I suppose from my own experience and probably from seeing it done by other members of staff and seeing how they teach" (Marie)
>
> "The way that I've learnt is by following my colleagues and people who have taught before me, and we've used similar methods because we see what works, and update it" (Marie)

4.5 Pedagogical Timings of the Pedagogical Approaches

The Pedagogical Timings refers to when the three Pedagogical Approaches of Visual Anatomical Imagery, Kinaesthetic Anatomical Skills and Clinical Application of anatomical knowledge were used in the teaching activities of a typical undergraduate physiotherapy degree programme. The Pedagogical Approaches had an element of increased complexity when they were revisited and resembled a spiral curriculum. The Pedagogical Timings do not indicate the absolute presence or absence of Pedagogical Approaches, but rather times of the most intensity. The Pedagogical Timings were divided into two major phases: 1st year phase and the Joint 2nd and 3rd year clinical phase. The 1st year phase was further divided into the sub-phases of Independent Student Studying and Practical Anatomical Tutorials. TABLE 10 on the next page gives an introductory summary of the Pedagogical Timings of the Pedagogical Approaches broken down into the major teaching activities of a given year.

Table 10: An overview of how the Pedagogical Approaches were related to Pedagogical Timings

Year	Teaching Activity	The Three Pedagogical Approaches		
		Visual Anatomical Imagery	**Kinaesthetic Anatomical Skills**	**Clinical Application of Anatomical Knowledge**
1st Year	Independent Study	• Online imagery (Lecture PowerPoints with voice overs, digital diagrams, digital photographs, digital illustrations, digital videos) • Books (diagrams, photographs, illustrations) • Anatomical software (two dimensional imagery, three dimensional imagery)	• Personal set of plastic skeletons loaned to each student for the year	• Clinical mini scenarios in anatomy textbooks
	Practical Anatomical Tutorials	• Live sketching by the teacher • Seeing cadaveric specimens • Seeing plastic anatomical models or skeletal parts • Seeing anatomical learning aids • Analysing movement through observation • Observing anatomical videos • Using interactive anatomical videos • Observing images from ultrasonography • Observing video recordings of students in an anatomy practical	• Manipulating plastic anatomical models or skeletal parts • Interacting with anatomical learning aids • Manipulating cadaveric specimens • Palpating other students	• Anatomy-for-physiotherapy-teachers discussing and solving clinical mini scenarios • Physically assessing simulated patients
	Summative Assessments	• Using images in questions • Questions based on tags on skeletons and cadaveric specimens	• Practical examinations requiring palpation and muscle activation on a living person	• Questions based on Clinical mini scenarios
2nd Year and 3rd Year	Student Clinical Placements	• Imagining anatomical structures beneath the skin • Interpreting radiological images	• Physically assessing patients • Being able to select and perform the appropriate diagnostic palpatory tests to confirm impaired anatomical structures	• 'Embedding' anatomy into every clinical physiotherapy work • Grooming anatomical inquisitiveness during clinical physiotherapy work • Students developing anatomical hypotheses of clinical problems

4.5.1 1st Year Independent student learning (1st Year usually)

The Independent Student Studying Phase was typically seen by all the anatomy teachers as a preparatory phase for the subsequent Practical Anatomical Tutorial phase.

> "We expect them (the students) to come in (to the Practical Anatomical Tutorial sessions) with some basic knowledge ... of what are the ... anatomical features they would need to know" (Marie)

The Independent Student Studying Phase was carried out outside the timetabled formal teaching sessions, like during their free periods, evenings and weekends.

> "The course expectation is therefore that they (the students) have to do some of that work in their own time" (Claire)

The idea of front-loading the Independent Student Studying Phase before the Practical Anatomical Tutorial Phase was aimed at reducing the amount of anatomical knowledge that the teacher had to teach within the time constrained Practical Anatomical Tutorial Phase, as exemplified by the following statements.

> "Essentially that is what is happening, we have offloaded (learning) to their independent study, and then we try and make the experience, when they come into a classroom, as efficient as possible in terms of gaining as much content as possible in a meaningful way in a short space of time" (Claire)

> "There is a lot of content to cover, and not a lot of time, and 'in order to get the most out of the time that we have contact time we have with you, you need to do independent work'" (Marie)

The Independent Student Studying Phase was typically used for learning the more factually-based anatomical knowledge, as illustrated by the following quotation.

> "I think if you structure your content such that students do all the fact based learning, knowledge based content early, in their own time they are learning. Then you don't need an enormous amount of face-to-face time for students to develop the necessary knowledge and skills." (Keith)

Some of the examples of factual anatomical knowledge the students were expected to learn independently were the:

> "Basic structure of key muscle groups. … Key components of certain things. … Basic structure of the heart" (Joshua)

The students used local university intra-nets for guidance on what anatomical knowledge they had to study. The intra-net referred students to pages on recommended anatomy textbooks, PowerPoint files and other visual resources they could use, as typified by the following statement.

> "The anatomy module I coordinate here does have a weekly, the hubsite, the virtual learning environment. They will have a folder for that particular week, with lots of details about the tasks, the reading that they have to do, the PowerPoints they have to look at, other visual videos or resources I can point them to, as well as the specific questions that they need to reflect on, so that they understand their learning, and then the detailed, uumm, page numbers in the textbooks that we want them to read" (Keith)

Four anatomy teachers spoke over archived PowerPoint slides and subsequently made them available on the anatomy course intra-net.

> "What we have done is, we have done voice-overs, we have a system here that's called ACA 360, where you can record a lecture live and then it stays in the system, so we do a voice-over of the lecture and the PowerPoint, they have got these." (Vanessa)

Some anatomy teachers used workbooks to guide the Independent Student Studying Phase.

> "Workbooks we have provided (to students) that I inherited from my predecessor, who basically put together a workbook of key muscles and key structures, so that we don't necessarily list everything there is, you know, just picked on key areas" (Kelly)

Although anatomy textbooks were a significant source of independent student learning, but there was a constant feeling among all the anatomy lecturers that there was no single anatomy textbook that could help them learn during the Independent Student Studying Phase

> "I don't think that there is one textbook that answers what they need … You can get all these things in different books and they are in isolation and are in four or five different textbooks in order to piece together the information" (Claire)

4.5.1.1 Limitations of Independent Student Learning

Three anatomy teachers said that the Independent Student Studying was not always done by some students, although the students eventually saw the importance of it.

> "Some of them (students) don't (do the prior reading) and some of them do. I think students eventually they realise that the more they invest beforehand into a session, the more they get out of that session, and we try and emphasis that point" (Keith)

4.5.2 1st Year Tutorial based learning (1st Year usually)

Practical Anatomical Tutorial learning was the most significant teaching activity that anatomy teachers had with physiotherapy students in terms of effort spent, financial cost and the time of the teacher during the first year of the three year physiotherapy undergraduate degree programme in all the universities.

> "We can have a lead lecture on anatomy and then most of our sessions are then tutorial-based" (Vanessa)

The Tutorial-based learning for all the anatomy teachers was centred and anchored in practical teaching, as exemplified by:

> "Teaching anatomy should take a predominantly practical format" (Marie)

There was a clear consensus among all the participants that anatomical teaching should come earlier before the clinical subjects. Six universities taught anatomy modules in the 1st year and one university taught anatomy across the first two years. Nathan's university was an exception and taught anatomy across all the three years.

> "In the first year at the previous (Post-1992-B University) we taught the ankle, knee, yeah and lumbar spine ... (and then in 2nd year) they did the upper limb, which included the thoracic spine, shoulder, elbow, forearm and hand. In year 3 and they then did the hip" (Nathan)

Nathan found the teaching layout difficult to understand because the students treated hip conditions in the 1st and 2nd year, but only learnt the anatomy of the hip joint in third year.

> "Yeah, which I was always found strange. … So they (the students) saw them (patients with hip joint problems) on (1st and 2nd year) placements, but not had a formal lecture or practical on it, which seems a bit not wise. … I think it could be rejigged better" (Nathan)

4.5.2.1 Rational for using Practical Tutorials

Marie attributed the use of practical tutorials to her own previous experience as a physiotherapy student.

> "Well I guess it comes from my own education as a physiotherapy student and, so when I did my degree, we had a lot of practical teaching and use of models, use of skeletons and uumm all kinds of teaching aids" (Marie)

The practical format of teaching anatomy was said by another teacher to suit physiotherapy students.

> "I think we found out that many physio students are, a lot of them are very practical learners" (Vanessa)

4.5.2.2 The type of Anatomical Knowledge taught in the Tutorials

All the anatomy teachers had to condense the anatomical knowledge they taught to the most basic, core and essential anatomical knowledge because they had a limited amount of time to teach, as portrayed by the quotation:

> "We only focus on the basics" (Samuel)
>
> "There isn't enough time to do everything, you obviously need to make sure that the students can function in a clinical environment and get things right to the basics, but I do worry that anything beyond the basics we have not covered, and it's a worry you know" (Samuel)
>
> "The ability to accurately diagnose is becoming even more important but you can only do that from a solid knowledge base because we are expected to be doing much higher level of clinical reasoning to make these decisions and actually that comes with really core solid foundation in anatomy" (Vanessa)

Core and essential anatomical knowledge described by the teachers could be divided into two categories: principles for reassembling anatomical knowledge and the functionality of anatomical structures (the role of anatomical structures).

4.5.2.2.1 The principles for reassembling anatomical knowledge

The principles for reassembling the anatomical knowledge helped to reassemble their forgotten anatomical knowledge. The principles could be similar to when you have forgotten what day of the week it is, but remember that the city council collects the weekly refuse bins on Tuesdays, which was done yesterday. So you then 'workout' or 'reassemble the required knowledge' that today is actually Wednesday based on principles of how weekly days are arranged and the weekly bin collection system.

> "It must be about principles that we can teach of how you can work things out, rather than saying 'you need to know ... an index (anatomical) knowledge'" (Joshua)
>
> "It is more important if they understand the logic of how things work together than the nitty gritty details of things like spellings" (Kelly)

Part of being able to reassemble anatomical knowledge is about understanding the broader organisational design of anatomical structures.

> "It is about classifications and how things are organised to help students to be familiar with anatomy" (Joshua)

Below are some examples of general anatomical principles that helped students in working out the logic of anatomical structures.

> “Key principles of muscular systems. … There are nerves that are sensory and some are motor (control muscles), so they are principles, aren’t they, of the nervous system” (Joshua)
>
> “The logic of limb development and dermatome and myotome (how a foetal spinal cord sprouts out spinal nerves that each supply and control a specific group of muscles and sensation to a specific patch of skin)”(Kelly)

Another principle suggested by three teachers of reassembling anatomical knowledge was that anatomical names are based on how anatomical structures look or where they are attached.

> “Let us see what principles you can still understand because anatomy is quite useful in the sense that if you have structures, they are usually named very sensibly, aren’t they, in relation to what they might do or their structure or attachments” (Kelly)

4.5.2.2.2 Functionality of anatomical structures

The functionality of anatomical structures and what the structures did on a person were highly regarded by all the anatomy teachers. Below are some of the described functionality examples:

> “Instead of them seeing anatomy as static, but to try and work out what it will do in real life” (Nathan)
>
> “In terms of anatomy, it’s about getting them (the students) to consider functional tasks and I think how a muscle or joint works in a functional way” (Marie)
>
> “When physiotherapists learn anatomy, certainly here at the Russell-A University, what we are trying to teach them is the functional anatomy, so how to apply the underpinning bone-muscle structure to function and thinking of it in that way. … When I am watching somebody do this movement, ‘what’s involved, what’s happening at the joint, what’s happening at the muscles’, so that we can go on to start the clinical reasoning; so it’s learning anatomy as well as all the factual content, and about how that fits into movement, an analysis of that.” (Vanessa)
>
> “Muscle activity and effects of gravity” (Marie)
>
> “ We talk about principles of stabilisers and mobiliser and talk of muscles that lie close to the joints and have a stability role (and those further away as mobilisers) (Kelly)
>
> “I ask myself as well, as in how important is it that you know the intricateness of this tubercle (a bony prominence) or how it relates to physiotherapy clinically when you are practising. Teaching-wise, I prefer trying to teach it in relation to function really” (Nathan)

4.5.2.3 Types of Anatomy Tutorials

There were two types of anatomy practical tutorials: Practical Classroom Anatomy Tutorials and Laboratory Cadaveric Tutorials.

4.5.2.3.1 Practical Classroom Anatomy Tutorials

The Practical Classroom Anatomy Tutorials were educational opportunities for the students to apply the factual anatomical knowledge learnt from the prior Independent Student Studying.

> "So for the practical sessions, we will look at applied, basic observation skills, we are looking at observation, palpation and movement analysis as well." (Keith)

The illustratory FIGURE 13 below, copied from Robert-Gordon-University, 2016b, paints a picture that makes it easier to understand the learning environment of the Practical Classroom Anatomy Tutorials portrayed by the subsequent five quotations.

Figure 13: An illustration of student peer-to-peer learning during Practical Anatomy Tutorials

The Practical Classroom Anatomy Tutorials typically used students themselves or hired human model .

> "So either with a human model, so one of the students in the group , we would demonstrate a particular joint etc., and we would probably also use a skeleton, part of a skeleton, arm or leg" (Marie)

The Practical Classroom Anatomy Tutorials in the eight universities extensively used the Visual Imagery and the Kinaesthetic Thematic Reinforcement concepts.

> "I think the students benefit more from a limited face-to-face way, that, uumm, enables the visual and kinaesthetic kind of learning to take place" (Keith)

Multiple human living bodies provided opportunities for students to see and feel how different anatomical structures felt like in different people.

> "So you can look practically and see the differences between individuals, which is exactly what they should be doing when they are out in the practical field and working on patients" (Marie)

The Practical Classroom Anatomy Tutorials were typically resource intensive teaching activities in terms of learning aids.

> "We have lots of models, so limbs, ankles, brains, respiratory system, different kinds of levels, some with some kind of pathology, some with working moving parts, so there is that kind of aspect that students can see, whether it's about biomechanics or whether it's about the lungs being inflatable or not, but we've got a variety of different things" (Joshua)

The teaching room had to specially adapt large teaching rooms and place numerous adjustable beds:

> "I think we need a big spacious room, where students can have a plinth and can mobilise around a plinth. I think we need good audio-visual facilities so that we can stream YouTube videos, interactive anatomy clips" (Samuel)

> "A practical lab that has up-down beds, so plinths that can be adjustable" (Joshua)

4.5.2.3.2 Laboratory Cadaveric Tutorials

The Laboratory Cadaveric Tutorials were tutorials carried out in specially designed anatomy laboratories that are heavily regulated by the Human Tissue Authority and the Human Tissue Act of 2004. The Laboratory Cadaveric Tutorials had numerous human cadaveric specimens called prosections. Prosections are carefully dissected out to show selected anatomical structures and that could be seen or carefully manipulated by the students.

> "We visit the dissection lab also and they can see (anatomical specimens)" (Claire)

> "But the really nice thing about Prosections is that you can do those things ... (such as) pull on the nerve on one end and you can see it move on the other end and that give them that concept of neural dynamics. So those things are really nice." (Claire)

4.5.2.4 Problems

Marie warned that running student-centred Practical Anatomical Tutorials on time can be a challenge:

> “In a practical session, you might get side-tracked if you get a question then you might get side-tracked and you might lose time” (Marie)

4.5.3 1st Year Anatomical Assessments

The assessments typically were in two formats: written assessments and practical assessments that required physical learning aids. Written assessments included anatomy Multiple Choice Questions (MCQs) and Short Answer Questions (SAQs). MCQs were typically used to assess “the breadth of knowledge” (Quotation 109: Joshua) because they could sample a much wider range of anatomical knowledge. Some of the SAQs were on the application of anatomical knowledge to clinical physiotherapy scenarios.

> “SAQs, where they (the students) are asked to think about the anatomy and how that relates to patient physiotherapy treatment” (Joshua)

In all but one of the physiotherapy departments, the Visual Anatomical Imagery was used during the end of 1st year summative practical assessment, where students had to identify anatomical structures set on cadaveric specimens.

> “We have an anatomy viva examination (oral and practical examination). The students have to find a couple of body points, such as ligaments, muscles and movement analysis” (Samuel)
>
> “It is in the 1st year. They also have a spot exam, a cadaver exam which is what I would consider to be a pure anatomy exam” (Vanessa)

Most anatomy-teachers-for-physiotherapy used living people during the practical examinations:

> “Assessment should include some sort of practical component, where students must activate, palpate and find things on a models, a live model, as well as on the skeleton” (Keith)
>
> “We have practical exams here, we ask them to demonstrate certain movements then we ask them questions on what produces that movement and then we can question them about the detail” (Nathan)

Passing the end of 1st year anatomy examination was described by most of the anatomy-teachers-for-physiotherapy as a way of checking the standard of the anatomical knowledge learnt.

> "If the student has passed the 1st year, then they would have completed practical tests, written examinations, so that they can attain to certain levels of performance" (Marie)

4.5.4 2nd and 3rd Year Clinical placement-based learning

Seven anatomy teachers taught most of the anatomical knowledge during 1st year, while the Clinical Lecturers and the Practice Placement Educators applied the anatomical knowledge to physiotherapy clinical situations during 2nd and 3rd years.

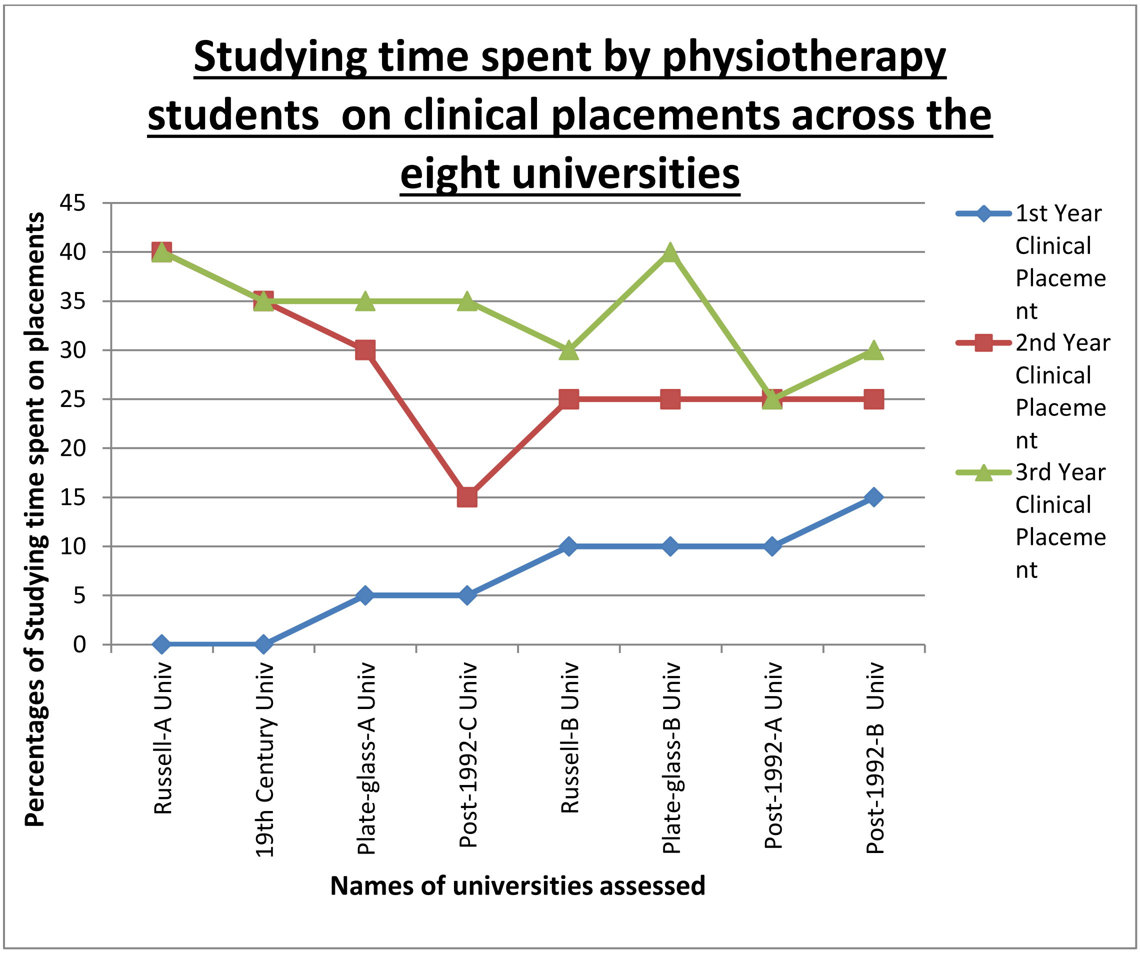
> "They do most of their pure anatomy learning within the first year. So we won't go back to re-teaching them any basic structural anatomy (in 2nd and 3rd year), that's all done in year 1. So what they do in second year, they will do cardiorespiratory disease and disorders, they do neuro and multi therapeutic studies, which is more of a musculoskeletal type module. … We don't re-teach them anatomy when they get to second year. So they cover all anatomy in first year." … "In third year, of course we don't do any anatomy teaching" (Vanessa)

> "We don't have any specific detained anatomy in second year, we have more physiotherapy modules like neurology and musculoskeletal practice and they will be actually using anatomy in those" (Keith)

4.5.4.1 Occurrence of Clinical Placements

Physiotherapy students spent significant periods on clinical placements in NHS hospitals and the most time across all the universities was spent on 3rd year clinical placements, as indicated in GRAPH 7 below.

Graph 7: Studying time spent by physiotherapy students on clinical placements across the eight universities



The graph was assembled from a website that compiled comparison information among the BSc Physiotherapy programmes, but did not have information on the 4th year of the Post-92-C University.

There were typically minimal clinical placements during the 1st year throughout the assessed universities. The universities with the highest percentage of time spent in clinical placements during 1st year had among the lowest clinical placement time during the 2nd and 3rd years.

In the current study, three anatomy teachers felt that the clinical student placements were not emphasised in 1st year because the anatomical knowledge of the students was not developed well enough to support clinical reasoning.

> "If you send them out in first year when they haven't done all of the anatomy, then they can't accurately approach a patient because you can't start to formulate hypotheses for what's wrong with somebody if you don't know the anatomy of that area" (Vanessa)

4.5.4.2 Clinical Placements influenced type of anatomical content learnt

There was a fishing analogy used by three anatomy teachers which drew similarities between the strategies used by physiotherapy students to learn anatomy and learning different methods of fishing. The fish represented anatomical knowledge to be learnt and the total range of anatomical knowledge that the physiotherapy students were expected to learn was given an arbitrary range of Fish-No-1 to Fish-No-40. The fish pond represented the collective environment of clinical student placements, which were usually carried out in hospitals. The times on clinical placements were the opportunities to use different fishing strategies to catch Fish-No-1 to Fish-No-40, but the fishing time was not enough to catch all Fish-No-1 to Fish-No-40.

> "You know you might catch one or two (fish) if you are lucky, but you won't catch forty (fish). It's a problem, isn't that, it's a worry" (Samuel)

There was a realisation shared by all teachers that physiotherapy students cannot be expected to know all the anatomical knowledge necessary to underpin all the clinical fields of physiotherapy equivalent to Fish-No-1 to Fish-No-40.

> "We know we can't teach (everything), we know that we can't assume students will have the knowledge of every (anatomical) system in the body" (Joshua)

> "We get challenges all the time from clinicians (who say) 'I don't know why you are teaching them this?', 'Why do you teach them so much of this?'', and at the end of the day all we can provide in three years is a taster of each bit, because each clinician that comes has their pet bit that they would really like students to have" (Claire)

As a pragmatic solution, students were expected to know the anatomical knowledge within the field of physiotherapy in which the students would be working. For example, students working with patients with lower limb clinical conditions might need anatomical knowledge of the lower limb named Fish-No-8 to Fish-No-12, while students on placements with patients with brain related clinical conditions, like strokes, might need anatomical knowledge of the brain named Fish-No-22 to Fish-No-28.

> "I used to work in Rheumatology, so my lower limb anatomy was quite good because I dealt with a lot of hip and knee replacements, but my upper limb anatomy was not that good" (Samuel)

> "If we are going to go out on placement and they are going to be going on orthopaedics treating hips and knees, yes they are gonna really going to look up and revise anatomy of the hip and knee. If they go to the Hand Unit they are gonna look up the hand but they won't see any patients for that 4 weeks that have got hip and knee problems." (Vanessa)

Anatomical knowledge held by physiotherapy students was ever-changing, sometimes diminishing and sometimes absent.

> "Different knowledge will be of different importance to different students as they qualify and start working, and they will have different importance at different times" (Keith)

> "So they will … improve (knowledge) depending on where they need to go and where their career takes them really" (Vanessa)

4.5.4.3 Two ways of teaching clinical anatomy during placements

Two major pedagogical patterns on how anatomy was taught to physiotherapy students emerged from the study: the implicit and explicit teaching of anatomy during the clinical placements. The implicit teaching of anatomy was characterised by informal anatomy teaching strategies and was described by seven anatomy-teachers-for-physiotherapy, while the explicit teaching of anatomy was described by the remaining teacher.

4.5.4.3.1 The implicit teaching of anatomy during clinical placements

The implicit teaching of anatomy during the clinical placements was hallmarked by anatomy teachers assuming that the Clinical Student Placement Supervisors knew what anatomical knowledge and skills to teach, how to teach and evaluate the teaching of physiotherapy students during the clinical placements. There was no established and regular communication between the anatomy-teachers-for-physiotherapy and the Clinical Student Placement Supervisors.

The anatomy-teachers-for-physiotherapy said that the Clinical Student Placement Supervisors assumed that the students learnt all the required anatomical knowledge by the end of the 1st year.

"They have covered all of their anatomy, generally the anatomy is a really good standard by the end of 1st year" (Vanessa)

"We assume a certain amount of knowledge in year 2, we assume that they have done all of their basic skills and we assume that they know (by the time they start 2nd year)" (Marie)

The experiences in the clinical placements provided practical and clinical opportunities for the students to use the anatomical knowledge and skills learnt during the 1st year and it motivated the students to appreciate the importance of anatomy:

"I think that's sort of a driver when they get out on to 2nd year, and they normally come back after the placement, really, highly motivated to study even more depth, so yeah, … So they realize they can't be a good physiotherapist without sound anatomical knowledge" (Vanessa)

There was a desire expressed by three anatomy-teachers-for-physiotherapy that within the implicit teaching there ought to be better sharing of curricular details among anatomy teachers.

"We also need to maintain the awareness of what is going on (in other modules) and you know what the specifics are on other people's modules" (Marie)

The anatomy teachers also assumed that the Clinical Lecturers and the Clinical Student Placement Supervisors reinforced the anatomical knowledge the students had learnt during the 1st year without verifying it.

"We don't know for sure that it (reinforcement of anatomical knowledge in 2nd and 3rd year) will be done" (Marie)

"I am not sure off the top of my head whether it is implicit or not, but what I certainly know that when students before they go on clinical placements, they often do revise their anatomy, but it's not something that I am aware of that is explicitly written in the module" … "I am not sure of the statistics of who does it (revises anatomy in 2nd and 3rd years before going to clinical placements) and who doesn't" (Keith)

4.5.4.3.2 <u>The explicit teaching of anatomy during clinical placements</u>

The explicit teaching of anatomy during the clinical placements was characterised by an anatomy teaching leadership that promoted greater sharing of curricular information, ideas and expertise for teaching anatomy between the anatomy teachers and the Clinical Student Placement Supervisors.

Only the Plate-Glass-A university lead by the Anatomy Theme Lead, Kelly, had explicit teaching of anatomy during the clinical placements. Kelly led a committed team of anatomy teachers and Clinical Student Placement Supervisors.

> "It is good to have a dedicated anatomy team to share ideas." (Kelly)

The Clinical Student Placement Supervisors made the students realise the importance of learning anatomical knowledge during one-to-one tutoring in the placements and reported back to the Anatomy Lead:

> In 2nd year – "They can then realise when they get to a point where they are thinking 'okay, this person (the student supervisor) is going to ask me about x, y and z anatomical underpinning', then if they then realise it's one to one with the clinical educator (student supervisor) , that is when they get it, that's when I think they really start to step up because they realise that there is no way out. ... It tends to typically happen not in year 1 and I think their mentality is still school and college" (Kelly)

Some of the Clinical Student Placement Supervisors were very good at reinforcing the anatomical knowledge that would have been previously taught by anatomy teachers during the 1st year.

> "So, some clinical educators (Clinical Student Placement Supervisors), within the time of clinical placement will ask a lot of underpinning anatomy. … I would encourage clinical educators as well, to be asking questions because some of the clinical educators are great at it and kind of gather as much of the information from the students as possible, so that they see the relevance. Other are a little bit... " (Kelly)

There were intentional and scheduled meetings between anatomy teachers and the Clinical Student Placement Supervisors to strengthen the learning of anatomy during the clinical student placements.

> "Those kind of sessions are good, when we have sessions with the clinical educators" (Kelly)
>
> "Then what I like is when we have kind of debriefing sessions with the clinical educators" (Kelly)

The meetings between anatomy teachers and Clinical Student Placement Supervisors were helpful because they shared information on the anatomy curricula and prevented students from misrepresenting information to Clinical Student Placement Supervisors what they had been taught by the anatomy teachers.

"So it's quite nice then at various times during the academic year, we invite clinical educators in and talk to them about various things in terms of students education, so that when students go on placements, we send a kind of skills set with them, so that in year 1, they have covered this and this, so that the educator (CSPS) knows that they covered whatever. That's the difficulty, the students will say 'oh no no, I have not covered this in my life', so they know that we have given the information to the clinical educators, so they can't say that anymore, which is a good thing" (Kelly)

The Anatomy Theme Lead Lecturer saw a greater scope for improving the explicit learning of anatomy and wished for more formal linking and referring of various learning resources of anatomical knowledge to non-anatomy teaching sessions within the three physiotherapy undergraduate degree course, i.e. to all the other physiotherapy modules.

"If I had everything we wanted, I would be linking the anatomy to everything (physiotherapy knowledge) we teach, so that in the ideal world, whether it was done in the anatomy suite (dissection laboratory) or maybe online resource, literally you could just tap into something before you kind of get them to do whatever. So if you are gonna do the ligaments of the knee, 'let's refresh it now, let's see it, let's look, you know, what those ligaments look like'" (Kelly)

Kelly's long career of over 20 years at the same school and being given significant power in managing anatomical teaching contributed to the presence of explicit teaching strategies. Kelly had additional roles of being the Anatomy Theme Lead for the BSc Physiotherapy degree and postgraduate anatomy degree specially designed for physiotherapists and the Anatomy Laboratory Link Tutor for physiotherapy.

"I have input across all three of those areas (musculoskeletal, neurology and respiratory/cardiovascular, which are the core clinical areas of physiotherapy) as an anatomy lecturer" (Kelly)

"We have an anatomy (cadaver laboratory) link tutor, that's me now, okay so the anatomy (for physiotherapy) tutor role is established. So I think what happened is that the anatomy would be taught by anatomists (initially) and we would gradually share it and gradually over time that person would come online as an anatomy teacher" (Kelly)

"So basically what we have talked about so far is undergraduate, but the other modules I run include applied clinical anatomy for post-grads and … and there is sort of a post-graduate certificate in anatomy studies that is based here as well" (Kelly)

With the teaching management power Kelly had, she was able to strategise and reflect on the chronological development of anatomical knowledge and skills from 1st year students right, to postgraduate physiotherapy students. In contrast, anatomy teachers in physiotherapy schools with implicit clinical teaching of anatomy were 'modulated' and their teaching influence was restricted to the one or two modules with significant anatomical tutorials.

4.6 Conclusion of the Findings Chapter

Eight anatomy-teachers-for-physiotherapy from eight universities were interviewed and 72,292 words in the transcripts were analysed using grounded theory. The participants had varied physiotherapy and teaching experiences. The three Pedagogical Approaches of Visual Anatomical Imagery, Kinaesthetic Skills and the Clinical Application of anatomical knowledge emerged from the analysis of the transcripts. The three Pedagogical Approaches were resource intensive pedagogical concepts and required skeletons for each student, numerous anatomical learning aids, various anatomical software, specially designed cadaveric laboratories and access to patients in hospitals.

There was strong evidence of spiral learning based on increasing complexity and sequential learning. Anatomy modules were typically taught during the 1st year and were seen as a precursor for the clinical physiotherapy subjects. Student-centred Practical Anatomical Tutorials were the main activity for teaching anatomical knowledge; used anatomical learning aids and skeletons, palpating other students and using cadaveric specimens.

The application of anatomical knowledge on real patients in the 2nd and 3rd years was supposed to be the zenith of anatomical knowledge, but was implicitly and poorly run in seven of the eight universities. The implicit teaching had no laid out learning objectives, no dedicated anatomical academics to manage it, had informal assessments and everyone assumed that anatomical learning was going well without verifying it. The only exception was Kelly's university, where the anatomy leadership brought about explicit teaching of anatomy and offered the best practice of running anatomical learning in the hospitals.

There was a general palpable absence of mentioning pedagogical theories by the eight anatomy teachers interviewed and they tended to describe their teaching activities on a practical level. The Discussion Chapter, starting on the following page will relate these teaching practical activities to existing pedagogical theories.

5 Discussion Chapter

5.1 Introduction

The main aim of the Discussion Chapter is to engage, explain and analyse the often practical teaching activities of anatomy teachers for physiotherapy in the Findings Chapter at a theoretical level. The 4CID and its underlying of the Cognitive-Load theoretical frameworks will be used for explaining and analysing the teaching descriptions in the Findings Chapter, and deviations from the theoretical frameworks will be explored. The descriptions of the Pedagogical Backdrop, Pedagogical Approaches and Pedagogical Timings will be reorganised and grouped into five major pedagogical concepts to make it easier to critically examine their descriptions, theoretical underpinning and future implications.

The 4CID model was found to be the most appropriate theoretical framework for explaining the research findings for several reasons. The broader aims of the 4CID model suits the teaching of anatomy across the three undergraduate years because the 4CID model analyses learning at a course or curriculum level, and was designed with medical education in mind (Merriënboer & Kester, 2014). The 4CID model was designed for learning complex information (Merriënboer & Kester, 2014) and augurs well with anatomy because anatomy is a difficult subject to learn and was described as “very daunting” by Samuel (Quotation 5 on page 84), a view supported by literature (Bergman et al., 2011; Clancy, McVicar, & Bird, 2000; Johnston, 2010; Khan et al., 2015). The 4CID theory and the Cognitive-Load theoretical frameworks are attractive for explaining multimedia in teaching and learning (Mayer, 2014c), which is heavily used in anatomical teaching. The 4CID model and its underlying Cognitive-Load theory have extensive literature bases that are helpful for critically examining the research findings from the previous chapter.

The 4CID promotes the use of authentic learning tasks and experiences that mimic as close as possible real life problems that students would face in clinical practice after graduation (Merriënboer & Kester, 2014). Likewise, several learning tasks related to clinical physiotherapy requiring anatomical knowledge and skills were used by anatomy-teachers-for-physiotherapy in the current study, such as palpation, physically assessing patients, solving problems of patients and treating patients. These anatomical tasks were not just knowledge-based, but also incorporated knowledge, skills and attitudes, the same set of attributes as those promoted by the 4CID model (Merriënboer & Kester, 2014). The 4CID theory promotes teaching repetition through part-task practice to increase automation of skills and bodes well with the repetition and reinforcement of teaching by the anatomy teachers in this current thesis.

The five most significant pedagogical concepts that emerged from the Findings Chapter are presented in TABLE 11 below, together with theoretical principles explaining them.

Table 11: The five major pedagogical concepts used to teach anatomy for physiotherapy

Major pedagogical concepts	**Theoretical principles underpinning the major pedagogical concept**	**Described and discussed in the following sections**
1. Spiral curriculum strategies	i. Sequencing principle of the CLT & 4CID theories ii. Fading principle of the CLT & 4CID theories (implicit vs explicit anatomical teaching during the student placements) iii. Repetition and reinforcement (Part-task Practice of the 4CID theory)	Section 5.2.1 on page 119
2. The use of Visual Anatomical Imagery	i. Paivio's Dual-Coding theory: verbal vs imagery ii. Multimedia principle of the CLT & 4CID theories	Section 5.2.2 on page 133
3. The use of Kinaesthetic Anatomical Skills	i. Dual-Coding theory of Paivio: haptic & imagery vs verbal cognitive processing	Section 5.2.3 on page 135
4. Strategies for teaching the clinical application of anatomy	i. Fidelity principle of the CLT & 4CID theories ii. Variability principle of the CLT & 4CID theories iii. Completion strategy of the CLT & 4CID theories	Section 5.2.4 on page 140
5. Using anatomical principles for metacogniti on	i. Germane Cognitive Load of the Cognitive-Load theory's	Section 5.2.5 on page 143

5.2 The five most dominant teaching strategies

5.2.1 Spiral curriculum strategies

5.2.1.1 Why the spiral curriculum model was chosen?

A literature search was made to find curriculum theories that could help explain the triad of features from the Results Chapter: learning content arranged in increasing levels of complexity over time, the re-visitations of similar concepts and a chronological decline in teaching support. Among the curriculum theories that were reviewed were Bloom's Revised Taxonomy, Kolb's cycle of experiential learning theory and a spiral curriculum model. The spiral curriculum model will be argued as the most appropriate of the three curricular models in explaining the triad of three features because of a number of reasons, but the inappropriateness of the other two curricular models will be first discussed.

5.2.1.1.1 Bloom's Revised Taxonomy model

The original Bloom's Taxonomy curriculum model (Bloom, Englehard, Furst, Hill, & Krathwohl, 1956) was later revised by his former student, who switched the order of the last two stages and created the Bloom's Revised Taxonomy (L. W. Anderson et al., 2000). The Bloom's Revised Taxonomy aims to use the principle that cognition processing can be arranged in increasing levels of cognitive difficulty (L. W. Anderson et al., 2000). The levels start from remembering, then understanding, then applying, then analysing, evaluating and eventually creating knowledge (L. W. Anderson et al., 2000), and allow similar content and concepts to be revisited and reinforced in each of the six stages. The last stage of evaluation often leads to new ideas that can be fed back into the earlier cycle stages of applying, analysing and evaluating information, i.e. a form of learning cycle (D. C. M. Taylor & Hamdy, 2013)

The existence of six discreet hierarchical levels of cognition of Bloom's Revised Taxonomy have been confirmed and validated in learning anatomy (A. W. Phillips, Smith, & Straus, 2013). Bloom's Revised Taxonomy in the anatomy sector is predominantly used for assessments (De Bruyn, Mostert, & van Schoor, 2011; Morton & Colbert-Getz, 2017; A. W. Phillips et al., 2013; Shaibah & van der Vleuten, 2013; Claire F. Smith & McManus, 2015), and rarely in teaching (Whillier & Lystad, 2015). Anatomical assessments typically assess the lower levels of the Bloom's Revised Taxonomy (Morton & Colbert-Getz, 2017; Shaibah & van der Vleuten, 2013; Claire F. Smith & McManus, 2015), although all the six levels can be used (A. W. Phillips et al., 2013), even for the original Bloom's Taxonomy (De Bruyn et al., 2011). The lower two levels (Shaibah & van der Vleuten, 2013), the lower four levels (Morton & Colbert-Getz, 2017), the lower five levels (Claire F. Smith & McManus, 2015) of Bloom's Revised Taxonomy were used in anatomy assessments. In the UK 30 years ago, the first two levels and the first three levels were used during the first year and the first two years respectively of a physiotherapy degree programme, although the term 'Blooms' taxonomy' was not used (Brook & Parry, 1985). The inventors of the Bloom's Revised Taxonomy welcomed the modifying of their taxonomy to suit various educational fields (L. W. Anderson et al., 2000). In response, a variant of Bloom's Revised Taxonomy was proposed for the anatomy field and its peculiar language, and was called the 'Blooming Anatomy Tool' with four levels (Thompson & O'Loughlin, 2015) and was successfully used for anatomy assessments (Meyer, Innes, Stomski, & Armson, 2016).

Blooms' Revised Taxonomy (L. W. Anderson et al., 2000) was not used because of several reasons. While the Bloom's Revised Taxonomy explains the increasing complexity of knowledge and the re-visitations of similar concepts, it does not account for the decreasing teaching support over time. The relevance of the sequencing principle in the Bloom's Revised Taxonomy was weakened by that levels requiring higher cognition processing could be started earlier than lower levels (L. W. Anderson et al., 2000; A. W. Phillips et al., 2013) and differed from the original Bloom's Taxonomy which followed a strict sequence of teaching and learning from the simpler cognitive processing to the more complex (Bloom et al., 1956). Lastly, there was no clear taxonomy theme/s that emerged from the thematic analysis of the study that could explain the other four major pedagogical concepts of the Discussion Chapter.

5.2.1.1.2 Kolb's cycle of experiential learning model

Kolb's approach to learning had three wings: a theory on experiential learning; a graphical illustration and a supporting Learning Styles Inventory (D. A. Kolb, Macintyre, & Rubin, 1971; D. A. Kolb, 1975; D. Kolb, 1984). Kolb's cycle of experiential learning has four sequential stages of concrete experience, reflective observation, abstract conceptualisation and finally problem solving (D. A. Kolb et al., 1971; D. A. Kolb, 1975; D. Kolb, 1984). Kolb's cycle has not gained traction on influencing the teaching or learning anatomy and only one study was found (Naug, Colson, & Donner, 2011). Students learning anatomy were able to progress sequentially through the first three stages of Kolb's cycle, but struggled with the last stage of problem solving that could be aided by re-visiting the earlier first three stages (Naug et al., 2011). The "students were surprised by their inability to complete the exercise" (p.234) at the first problem solving attempt (Naug et al., 2011), indicating forgetting of information or insufficient learning. In essence, Kolb's cycle allows re-visitation of the same underlying concept in each of the four stages and many of these cycles provide more numerous opportunities for re-visitations, i.e. "all learning is relearning" (p.194) (Alice Y. Kolb & Kolb, 2005). Consequently, Kolb's cycle has earned the name 'learning spiral' (A. Y. Kolb & Kolb, 2009). Learning over time follows a progression of increasing complexity (Alice Y. Kolb & Kolb, 2005) and implies that curricular content has to be sequenced in increasing levels of complexity.

Kolb's cycle was declined because of several reasons. The way the spiral learning of anatomy was spiralled over the three years in the current study could not be related to the four stages of Kolb's cycle, which could be completed in a much shorter time period. Kolb's cycle does not account for the fading support of the teachers or why students forgot things they were once sure about. Kolb's learning styles or the rest of Kolb's theory could not be related to the other four major pedagogical concepts of the Discussion Chapter described on TABLE 11 in page 118. Kolb's cycle was strongly linked to his four learning styles (A. Y. Kolb & Kolb, 2009; Alice Y. Kolb & Kolb, 2005) that have poor reliability and validity (Coffield, Moseley, Hall, & Ecclestone, 2004) and are unstable (Stumpf & Freedman, 1981), partly because they are based on students self-reporting their study processes rather than actual measurements (Price, 2004). There are fears that the learning styles are actually just learning processes (De Ciantis & Kirton, 1996) and that Kolb's views on learning processes and learning styles are ambiguous (Coffield et al., 2004), and consequently the collective criticism on the learning styles have curtailed the value of Kolb's experiential theory on learning.

5.2.1.1.3 Spiral curriculum model

The spiral curriculum version of the Cognitive-Load theory was the chosen curricular model that could best describe the triad that all the participants supported of learning content arranged in increasing complexity (Mayer & Moreno, 2003; Sweller, 1999), diminishing teaching support with time (Wijnen-Meijer, Cate, Rademakers, van Der Schaaf, & Borleffs, 2009), and re-visitations of similar content (Merriënboer & Kester, 2014). The spiral curriculum version of the Cognitive-Load theory could be better integrated with the Cognitive-Load theory that was used to explain the four major pedagogical concepts in on TABLE 11 in page 118. The participants did not use explicitly the specific terms 'spiral learning', 'sequencing principle' and the 'fading principle', but used their own equivalent descriptions. However, the terms 'reinforcement' and 'reinforce' (were mentioned 12 and 11 times respectively in APPENDIX 14 on page 245) and 'repetition' (mentioned five times) were explicitly used and was a preventative measure against the forgetting of previously learnt anatomical knowledge and mastered skills.

The word 'curriculum' comes from a Latin word for 'track' or 'race course' (Prideaux, 2003) and a spiral curriculum has come to mean a learning track arranged in a spiral manner. A spiral curriculum has four main characteristics: the revisiting of topics, visitations at progressively higher levels of cognition and difficulty, the later visitations referring to earlier learning encounters [rather than 'one shot affairs' of learning (Kabara, 1972)] and the competency of students increasing with each visitations (Harden, 1999). Spiral learning has become an integral part of medical education in the UK (Davis & Harden, 2003; Harden, Davis, & Crosby, 1997; Harden, 1999; Kabara, 1972) endorsed by the regulators of medical education in the UK (Education Committee, 1993) and the USA (Liaison Committee on Medical Education, 2013) mandate. Spiral learning has been extended to the education of a range of health related fields like nursing (LeeKeenan & Edwards, 1992) and in physiotherapy education in Europe (Broberg et al., 2003).

The spiral curriculum theory has been changing over the last 70 years, partly influenced by changing philosophical waves across education, and has a number of variations that include the spiral curricula of Tyler, Brunner and the Cognitive-Load theory. Furthermore, the practical implementation of the spiral curriculum phenomenon varies across different universities (Masters & Gibbs, 2007).

Tyler in the late 1940s believed that a good curriculum ought to be spirally arranged by promoting continuity of concepts over time, using progressive sequencing that gradually built on the breadth and depth of complexity of content and integrated of content vertically [across the different years and is also referred to as "vertical themes" (Ellaway, Dewhurst, & Cumming, 2003) or "golden threads" (Kent, Myer, Flisher, Mathews, & Lombard, 2005)] and horizontally (across other subjects taught around the same time) (Tyler, 1949). Tyler's spiral curriculum was geared to make schools resemble efficient mass production factories (Cullen, Harris, & Hill, 2012) with a rigid teaching curriculum and high teacher control, where the learning outcomes of students were pre-set by teachers before the start of learning (Tyler, 1949). Tyler's spiral curriculum ignored outcomes that could not be measured by teachers (Prideaux, 2003). The teacher-led perspective of Tyler does not augur well with the clinical student placements of the current study, where students decided on which anatomical area to focus on. Although Tyler's spiral curriculum described sequencing and visitations of concepts at more complex levels (Tyler, 1949), he did not allude to the fading principle of the diminishing support from teachers or how visitations aided the retention of knowledge. The implementations of the original prescriptive spiral curriculum of Tyler has diminished, although it has been instrumental in giving birth to more popular versions of spiral curriculum (Prideaux, 2003) with a less rigid control of learning objectives (Maher, 2004).

Jerome Bruner is well known for inventing the term 'spiral curriculum' (Bruner, 1960), a phenomenon that Tyler had promoted (Tyler, 1949). The 'spiral curriculum' is also referred to as the 'spiral of information' (Kabara, 1972), 'spiral of learning' (Kneebone & ApSimon, 2001), 'spiral learning' (Bruner, 1960; Masters & Gibbs, 2007), 'spiral integration' (Bandiera, Boucher, Neville, Kuper, & Hodges, 2013) or 'spiral model' (Brauer & Ferguson, 2015). Bruner supported Tyler's spiral curriculum of progressively increasing difficulty and re-visitations that are slightly more advanced levels (Bruner, 1960; Davis & Harden, 2003; Harden, 1999; Kabara, 1972). Bruner's spiral curriculum differed from the Tylerian model because it wanted to focus on purposeful gradual learning that is helpful for adult life, was more interested in the process of learning and factored in the cognitive development of the child according to Piaget (Bruner, 1960). However, Bruner did not give clarity on whether spiral learning was due to the natural cognitive development of a child increase in development or good teaching (Efland, 1995).

Behavioural psychology that influenced the spiral curriculum of Tyler and Bruner has given way to cognitive psychology as the dominant paradigm in educational psychology (Efland, 1995) because of the enormous body of knowledge on the brain that has emerged (Sweller et al., 1998). The spiral curriculum version of the Cognitive-Load theory best explained the triad of sequencing learning content (Mayer & Moreno, 2003), fading teaching support (Merriënboer & Sweller, 2010; Renkl, Atkinson, & Grosse, 2004) and the re-visitations of learning, and had the luxury of integrating with the theoretical framework explaining the other four major pedagogical concepts.

Pressure from Stenhouse helped steer interest away from the 'Product Approach Curriculum' (where the focus is on a well-defined end product of learning) of Tyler by indicating that there are other possible solutions other than the teacher's perspective and attention ought to be paid to the process of the spiral curriculum (Stenhouse, 1975). The Cognitive-Load theory version of the spiral curriculum used in the current study followed a 'Process Approach Curriculum' that is also called the 'descriptive model' (Prideaux, 2003). The 'Process Approach Curriculum' type of spiral curriculum used in the current study was a tedious process of restoring decaying information that would again be forgotten and the cycle occurring repeatedly because knowledge was not permanent. The evidence to support a 'Product Approach Curriculum' is weak from the current study because the anatomy teachers for physiotherapy were not sure how to evaluate successful learning of anatomy five years after graduation.

In addition, the spiral curriculum of the Cognitive-Load theory supports student-centred learning [unlike the teacher-centred spiral curriculum of Tyler (Tyler, 1949)] by seeking to understand the psychological processes occurring in the minds of students, like the working memory and the long term memory (Sweller et al., 2011, 1998; Sweller, 1988). There was strong evidence of student-centred learning from the current study that re-visitations of learning anatomy in the clinical years was based on what the students were interested in and what clinical placement they were in. While the Cognitive-Load theory ignores knowledge decay (forgetting) and the way that re-visitations help remembering, the weakness would be proposed as a modification for the Cognitive-Load theory (please refer to FIGURE 14 on page 148. The following three sub-sections will explain the spiral curriculum triad of the sequencing principle, fading teaching principle and the re-visitation principle using the theoretical framework of the Cognitive-Load theory.

5.2.1.2 Sequencing principle

In the current study, physiotherapy students learning anatomy were said to find anatomy difficult to learn and complicated because it was voluminous (please refer to Section 4.3.1), required intricate three-dimensional imagining (please refer to the latter half of section 4.4.1.2) and relating the knowledge to function (in Section 4.5.2.2.2) and touch (Section 4.4.2). Literature supports the view that anatomy is challenging because it is voluminous and has significant spatial complexity (Terrell, 2006) and has a huge vocabulary (Leonard, 1996). Consequently, the teaching and learning of anatomy was arranged in a certain sequence to make the learning of difficult anatomy more manageable.

The typical undergraduate sequence for learning anatomy for physiotherapy in the current study allowed anatomical knowledge to be gradually built from the previously taught or learnt anatomical knowledge, and is shown in TABLE 12 below.

Table 12: The typical sequence of anatomical teaching across the three years

	Anatomical content	**Sub-content**
1st Year	Teaching and learning *isolated* basic anatomy	Started with isolated bones, then isolated muscles, then how muscles functioned
	Teaching and learning *unified* basic anatomy	Physically assessing health patients (fellow students)
2nd Year	Revisiting 1st year basic anatomy	
	Teaching the clinical application of anatomy in musculoskeletal, cardiorespiratory and neurological physiotherapy	
	Applying anatomical knowledge on patients with clinical cases *under supervision* in hospitals	
3rd Year	Applying anatomical knowledge to patients with clinical cases with *less supervision*	
	Students undertaking a module called ‘Physiotherapy management of patients with demanding and complex conditions’	

During the 1st year, isolated anatomical content was initially taught separately and later combined and amalgamated. There was a typical sequence in how isolated anatomical content was taught: the anatomy of isolated bones started and muscles followed because they are attached on specific sites on bones. The contracting of a muscle attached to bone ends caused a joint to bend and caused functional movement. Combined anatomical knowledge was then applied on healthy fellow students during the Practical Anatomy Tutorials in 1st year. The teaching of anatomy progressed to teaching injured or pathological anatomical structures during the 2nd and 3rd years. Clinical anatomy was first taught in classroom settings and was then moved to the hospital settings. There was also a progression from being closely initially supervised to being loosely supervised towards the end of clinical placements. Complexity was most intense towards the end of the physiotherapy degree programme, as was typically evidenced by the 'Physiotherapy Management of the Complex Patient' module typically taught during the 3rd year, as shown in Appendix 15 on page 246.

There was an orderly sequence on how anatomical teaching was built up from the simpler concepts to the more complex ones to promote the most efficient learning sequence because some anatomical concepts are built upon other concepts. Earlier concepts were more separate and isolated, while later ones were more likely to be integrated and complex. The gradual building up of teaching content in spiral learning reduces the likelihood of overwhelming the students with knowledge (Harden, 1999). The widespread use of similar sequencing of anatomical teaching in the absence of guiding literature among most of the physiotherapy schools in the study may be due to a historical and pedagogical policy undercurrent among British physiotherapy schools. The teaching of anatomy for physiotherapy in the USA also follows historical teaching practices (Khan et al., 2015; Latman & Lanier, 2001; Reimer et al., 2013).

Anatomy has been classified as a "basic medical science" (p.156) (Latman & Lanier, 2001) and the term basic has connotations that it should be taught earlier before the more complex subjects. The term 'basic science' is probably misleading because anatomical knowledge and skills are used in everyday clinical practice of physiotherapy. The old Flexnerian model has been attributed to have cemented that pure basic sciences should precede pure clinical disciplines with no integration (Flexner, 1910), and hampered the integration between anatomy and clinical medical knowledge (Balla, Biggs, Gibson, & Chang, 1990) or clinical physiotherapy knowledge (Harden et al., 1984). The Flexnerian philosophy was discarded in the 1930s by higher ranking anatomy departments in the USA who taught more integrated anatomical teaching (Weiskotten, Schwitalla, Cutter, & Anderson, 1940). Others have suggested that running a module on the clinical physiotherapy application of anatomy in parallel to a pure anatomy course might be equally effective (Latman & Lanier, 2001), but puts a greater burden on the student of integrating the knowledge. More integration between basic sciences and clinical subjects was thought to be helpful in remembering information (Harden et al., 1984). Although the anatomy teachers in the study largely taught anatomy earlier and clinical disciplines were more extensively taught later, they taught the clinical application much earlier during the 1st year Practical Anatomy Practicals to promote integration. 1st year strategies of integrating clinical knowledge and skills with anatomy included using clinical mini scenarios in anatomy textbooks, the discussion and solving of clinical mini scenarios and assessing healthy fellow students and people who simulate patients, as indicated in Section 4.4.3 from page 96.

Anatomy modules of all the eight physiotherapy schools in the UK of this thesis were located in the 1st year of a typically three year course and is similar to the situation in the USA where one or two anatomy modules for physiotherapy (Mattingly & Barnes, 1994) were located in the 1st year or first two years of a physiotherapy degree programme (Abdur-Rahman, 2007; Berube et al., 1999; Latman & Lanier, 2001; Mattingly & Barnes, 1994; Reimer et al., 2013; Thomas et al., 2011). Anatomy for medical courses is also usually taught during the first year in the UK (Turney, 2007).

The Cognitive Load theory and the 4CID theoretical models use the sequential principle to best arrange a task class, where a task class is a set of tasks that progressively develop certain knowledge, skills and attitude threads (Merriënboer & Kester, 2014). The sequencing principle, synonymous to the pre-training principle (Mayer & Moreno, 2003), initially promotes the learning of components of a complex task separately and integrates them towards the end. The sequencing principle supports the gradual development of concepts from simple to complex over time, rather than giving the full complexity at once at one point in time (Merriënboer & Kester, 2014). It is not just the gradual increase in complexity that is important in Cognitive-Load theory circles, a more spread-out learning of anatomy is preferable to congested learning in a shorter period of learning anatomy (Terrell, 2006).

Instructional content of low complexity during the initial learning stages creates lower intrinsic loads (Sweller, 1999) in the working memory of students (Mayer & Moreno, 2003), unlike starting with more complex learning. Students who were exposed to a sequenced instruction performed better on problem-solving transfer tests than students who did not in three separate studies (Clarke, Ayres, & Sweller, 2005; Mayer, Mathias, & Wetzell, 2002; Pollock et al., 2002). The teaching of anatomy was said to use the sequencing principle to make it easier for students to solve problems that patients presented with in hospitals, but could not be confirmed because the anatomy-teachers-for-physiotherapy did not typically teach beyond the 1^{st} year.

It is very important for a teacher to know at which part of a learning sequence a student or class is at prior to starting to teach the next block of anatomical information on a teaching sequence (Terrell, 2006). It is common for medical students starting their clinical training to have a review of the anatomy learnt during the pre-clinical years (T. M. Scott, 1993), as was done in the present study. Despite the brief review of anatomy at the start of 2^{nd} year clinical lectures and tutorials, there was weaker intentional sequencing during the 2^{nd} and 3^{rd} years. The sequence principle was complemented by the fading principle described below.

5.2.1.3 The fading principle

In the current study, the support of the teachers to the physiotherapy students was front-loaded and tailed off towards the end, but in a poor way. Anatomical teaching support provided by anatomy-teachers-for-physiotherapy was explicit and extensive during the 1^{st} year. The anatomy teaching support during the 2^{nd} and 3^{rd} years was much less and implicit, and was given by the clinical specialist physiotherapy lecturers and Clinical Student Placement Supervisors. During the 3^{rd} year, the Clinical Student Placements Supervisors did less of the anatomy supervision because the students were becoming more autonomous.

The anatomy teachers gave tremendous and explicit teaching support during the 1^{st} year through the designing of Anatomy Workbooks for guidance, making talked over PowerPoint lecture slides, developing an intranet presence for anatomy modules and designing, preparing and manning the Practical Anatomy Tutorials. During the 2^{nd} and 3^{rd} years, the anatomy teachers implicitly delegated the anatomy teaching to the clinical specialist lecturers who lectured on the clinical physiotherapy relevance of anatomy, while the Clinical Student Placements Supervisors supervised students on how to use anatomical knowledge and skills on patients during hospital placements.

The reduction in anatomical teaching support from explicit 1^{st} year teaching to implicit teaching in the 2^{nd} and 3^{rd} years suffered a cliff-edge drop in support after the 1^{st} year. The exception was Kelly's university that had a gradual decline and had an explicit programme of anatomy learning during clinical placements in the 2^{nd} and 3^{rd} years. The transition from extensive 1^{st} year teaching support to implicit teaching support was characterised by poor, informal and ineffective communication, collaboration and discussions between anatomy-teachers-for-physiotherapy and the clinical lecturers or student supervisors. It was not clear if the three groups of teachers were teaching the same anatomical content, were using the same pedagogical teaching strategies or had the same expectations of learning anatomical knowledge and skills. Anatomy-teachers-for-physiotherapy did not have full confidence that anatomy was taught or learnt at all during the clinical placements.

Well-timed intentional instruction from the teacher has been shown to generate better mental imagery than when the students are left on their own (Clark & Paivio, 1991). There is a danger among the seven universities with implicit anatomy teaching that the physiotherapy students may be receiving no anatomy supervision at all, although they may still receive supervision in other physiotherapy areas. The anatomy teachers did not handover the ‘anatomy teaching baton’ at the start of the 2nd year to the specialist physiotherapy teachers and the Clinical Student Placement Supervisors. The lack of formal handover had the potential of making a sudden cliff-edge drop in teaching support because the subsequent teacher would not know where the last teacher left off or know of the learning progress of the students. It is important to make sure that sufficient learning has occurred before going to the next component of a series of components (Clarke et al., 2005). The lack of explicit teaching of anatomy in the clinical years may be caused by the poor ability or reluctance of clinicians to teach anatomy. The clinicians may not be confident in teaching anatomy (L. Cole, 1932; McCrorie, 2000) or basic sciences of diseases (Koens et al., 2006; McCrorie, 2000) because they may have probably forgotten their basic sciences (Jamieson, 2001; McCrorie, 2000) and may not have the time to keep abreast of basic science literature (Koens et al., 2006; McCrorie, 2000).

The fading guidance of the Cognitive Load theory (Merriënboer & Sweller, 2010; Renkl et al., 2004) and 4CID theory (Merriënboer & De Croock, 1990, 1992), alternatively called the scaffolding principle (Merriënboer & Kirschner, 2013), describes how support from the teacher gradually reduces, as the sophistication and automation of the schemas in the long-term memory of students increases. The fading principle encourages less teacher support of learning tasks within a task class towards the end of the learning period (Merriënboer & Sweller, 2010; Renkl et al., 2004), while the completion principle means that students are able to solve the full conventional problem on their own at the end of the learning period (Renkl et al., 2004). Insufficient teaching support can be detrimental to learning and acceptable support has to be of the right type, amount and timing (Merriënboer et al., 2003). Teaching support should ideally ensure that the learning demands placed on the students should be gradual, have ‘a smooth transition’, and not have ‘abrupt changes’ p.62 (Renkl et al., 2004) or cliff-edges (Renkl, Atkinson, Maier, & Staley, 2002).

5.2.1.4 Reinforcement and repetition to minimise the decaying of temporary knowledge

This section on reinforcement and repetition will start by describing how repetition was used in the current study, then possible mechanisms of forgetting and how the Cognitive-Load theory contradicts forgetting. The possible errors the Cognitive-Load theory may have made of ignoring the forgetting phenomenon will be discussed. A new version of the Cognitive-Load theory accommodating forgetting will be proposed and implications for teaching will be discussed.

A major theme of the spiral curriculum that resurfaced time and time again during the interview transcripts was the repetition and reinforcement of similar anatomical knowledge and skills in the later teaching sessions. The phenomenon of revisiting knowledge as a way of remembering was earlier explained using the decaying nuts of squirrels in Section 4.3.5 on page 86.

The role that repetition and reinforcement played within a spiral curriculum was to restore forgotten or omitted knowledge and skills, a long known view (Kabara, 1972), as was indicated in Section 4.3.5 on page 86 on refreshing anatomical knowledge. For example before coming to 1st year Practical Anatomy Tutorials, the students were expected to read on bones of the knee joint from their Anatomy Workbook, then from their recommended anatomy textbook and then physically review the knee bones at home from the set of bones that they were loaned. During the Practical Anatomy Tutorials in the 1st year, the students had to learn Kinaesthetic Anatomical Skills of locating the same bones during the surface anatomy sessions on fellow students. The students were expected to remember the basic anatomical knowledge at the start of 2nd year, where they were usually made to briefly revise the relevant anatomical knowledge learnt during the 1st year, before learning about the clinical application of the anatomical knowledge and skills on the bones of the knees on a range of musculoskeletal conditions. Lastly, the students were expected to use the same anatomical knowledge on the bones of the knees in assessing and treating the knees of patients during the student supervised placements in hospitals in the 2nd and 3rd years.

Re-visitations of knowledge themes were not just mere repetitions of the same knowledge but usually included an increased notch of complexity and competency and integrating new knowledge, of other subjects, in line with the spiral curriculum framework (Harden, 1999). The teachers could logically sequence their curriculum in terms of difficulty to promote higher cognitive thinking in the later courses (Harden, 1999). Carefully crafted anatomy curriculums with strong initial over-learning and the gradual building up of complex concepts from the earlier simpler concepts in a spiral and repetitive manner was recommended (D’Eon, 2006;

Harden, 2000). Assessments reinforcing cumulative integration across a degree programme also improve long-term recall (Cutting & Saks, 2012).

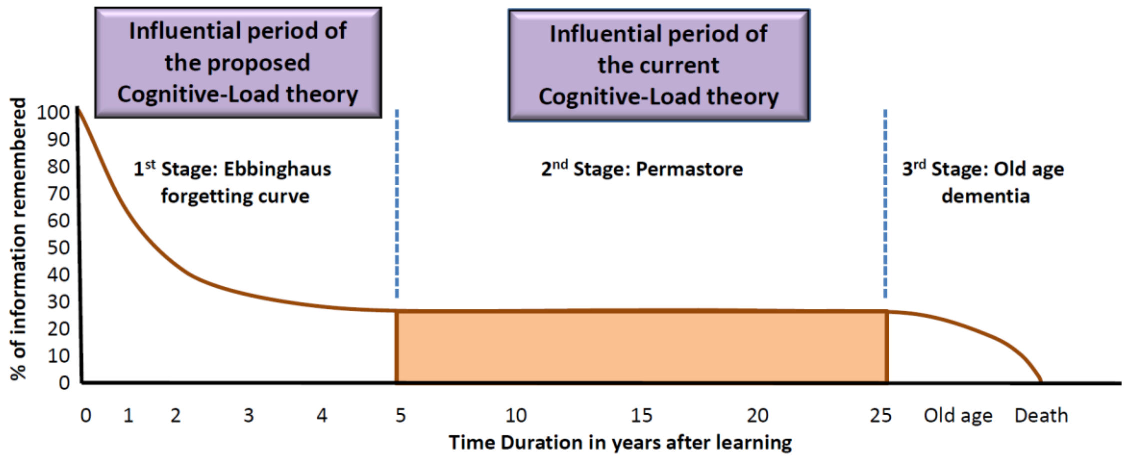
The 'forgotten information' perspective better explains the forgetting described by anatomy teachers during the current study than the 'seemingly forgotten' perspective (Loftus & Loftus, 1980; Norman, 2000). There are four possible explanations for the poor remembering by physiotherapy students in the early stages of learning when faced with voluminous anatomy content. The students may not have sufficient anatomical schema in their long-term memory to modify because the students were novice learners. The students may have too many requests for modifications of anatomical schema made to their cognitive architecture than they could cope with because the voluminous anatomical content being processed. The third possible explanation could be that the schemas in the long-term memory were poorly interconnected and lacked sufficient repetition and reinforcement to make meaningful and robust interconnections between the anatomical schemas. The fourth possibility could be that anatomical schema in the long-term memory fades in a process called trace decay (Baddeley et al., 2009; Gold, Murray, Sekuler, Bennett, & Sekuler, 2005; Towse, Hitch, & Hutton, 2000). Trace decay could be due to information being stored in biological molecules that have a limited lifespan and are liable to denaturing, while some neurones die naturally or may suffer weakening of synapses holding the information (Baddeley et al., 2009). If the memory molecules are not required for future remembering, they may be denatured or decayed to make way for new useful memory molecules. The trace decay phenomenon has been criticised for highlighting the importance of retrieval cues or learning environments, giving a poor explanation for why it is harder to remember if there is too much similarity between information to be remembered and that time is not a good predictor of information decay and remembering may actually improve with time (Nairne, 2002). The trace decay phenomenon possibility appears to be more attractive than the other possibilities because it also explains why the long-term memory has a limited memory capacity. The trace decay mechanism theory is among the most prominent forgetting theory, but is elusive to confirm in experiments because it requires one to follow the forgetting of memories periodically over time (Baddeley et al., 2009). However, the frequent checking of memories makes them stronger and defeats the purpose of following the natural progression of memories being forgotten (Baddeley et al., 2009). The desire by anatomy teachers and clinicians for anatomy students to have 'accurate' anatomical information (Bergman et al., 2011) may not be feasible in the context of trace decay and no reinforcement of knowledge.

Most of us forget information on a daily basis (Loftus & Loftus, 1980). Forgetting of information in the long-term memory is at odds with the views of scholars of Cognitive-Load theory who see the long-term memory as a permanent (or near permanent) store of information with an unlimited (or vast) capacity (Paas & Sweller, 2014; Paas et al., 2003; Simon & Gilmartin, 1973; Young et al., 2014). The permanence of the long-term memory has been bolstered by the ability of chess grandmasters who can remember around 100 000 chess board configurations (Amidzic et al., 2001; Chase & Simon, 1973; Simon & Gilmartin, 1973). Whether or not if some of the chess board configurations were forgotten over a period of a decade, recalling about 100 000 different memories after a decade is remarkable and gives strong evidence in support of the permanence of some of the memories.

The scholars of the Cognitive-Load theory may have made two errors in supporting the permanence of memories in the long-term memory. They based their theory on the permanence of memories in the long-term memory that would have survived after very long periods of over ten years (Paas & Sweller, 2014; Paas et al., 2003; Simon & Gilmartin, 1973; Young et al., 2014), in contrast to the learning and assessment in schools and university undergraduate degrees where courses are much shorter in duration and usually lasting a year. The second error could be that the scholars based their work on the memories of experts (Amidzic et al., 2001; Chase & Simon, 1973; Simon & Gilmartin, 1973), despite most of the teaching in schools and undergraduate degree programmes being to novice learners. Most of the research on the Cognitive-Load theory has been on children who are novice learners, whose learning strategies are significantly different from those of expert learners (Moreno & Park, 2010; Plass et al., 2010a). The current study found out that anatomical knowledge in the long-term memory was not permanent, but temporary because forgetting anatomical knowledge was a central feature in the current study. It was considered 'normal to forget anatomical knowledge' and the role of the anatomy teacher was to limit the overall knowledge decay through re-visitation and reinforcement of anatomical knowledge in the students.

The contradiction between the forgetful novice anatomy learners in the current study and the permanent memories of expert learners of the Cognitive-Load theory can be accounted for by appreciating that novice learners and expert learners are on different stages of the forgetting timeline in GRAPH 8 on the next page. The stable schema in the long-term memory of the chess grandmasters (Amidzic et al., 2001; Chase & Simon, 1973; Simon & Gilmartin, 1973) appears comparable to the permastore of information in the long-term memory which does not need frequent rehearsing to maintain it. On the other hand, novice anatomy learners in the current study had more fragile and temporary schema, which matched the much earlier 'Ebbinghaus: curve of forgetting' period. The time periods where the proposed amended and the current Cognitive-Load theories could apply has been illustrated on GRAPH 8 on the next page.

Graph 8: The amended Cognitive-Load theory in the forgetting timeline



Please note that the time duration is not in a linear time scale.

The long-term memory in Cognitive-Load theory circles is currently seen as having an unlimited storage capacity (Paas & Sweller, 2014; Paas et al., 2003; Simon & Gilmartin, 1973; Young et al., 2014). There was consensus among the anatomy teachers in the current study that it was not possible for the students to learn and remember all the anatomy covering all the fields of physiotherapy (please refer to Section 4.3.1 on page 84). The students were expected to focus on anatomical principles or anatomical knowledge, related to the clinical specialty they were focussing on in their hospital placement, as a way of curtailing the breadth of knowledge to a manageable level.

Some types of intentional reinforcement of concepts, such as expanding and elaborative rehearsing, are much more effective for reducing forgetting, and not the mere reviewing of the same image or materiel (Baddeley, 1997). However, there is resistance from the Cognitive-Load theory scholars against what they call needless repetition of processing anatomical information, such as long-winded and wordy explanations in books or teaching resources that should be replaced with succinct ones (Terrell, 2006).

There are established ways of reducing the forgetting phenomenon. Revisiting previously learnt memories reduces the decay of memories and more visitations made have an additive effect (Baddeley et al., 2009). The 4CID theory encourages the repetition of a sub-part of task (part-task practice), but unknowingly actually helped to restore forgotten or decayed schema. Expertise appears to develop in correlation with the amount of practice. The very best violinists have cumulative solitary practice of more than 10 000 hours, lesser violin experts 7500 hours and 1500 for dedicated amateurs (Ericsson, Krampe, & Tesch-Römer, 1993). Designing anatomical teaching solely centred on knowledge retention in the long-term memory and remembering is not enough, although designing a curriculum focused on information retention is easier than designing a teaching curriculum geared for knowledge transfer (Mayer, 2002). However, remembering knowledge is a precursor for knowledge transfer, at least in Revised Bloom's Taxonomy paradigms, where remembering is the first stage and applying (knowledge transfer) the fourth stage of six progressive cognitive processes (L. W. Anderson et al., 2000). Anatomy teachers in the current study were concerned about their students forgetting anatomical knowledge because it was required for later higher cognitive executions.

The teaching activities in the current study were commensurate to a version of spiral learning that used careful sequencing of content, fading support from teachers and repetition of similar topics. Although spiral learning has a weakness of not being made a dominant pedagogical framework to enable its positive and negative effects on learning to be assessed (Dowding, 1993), it appears to play a complementary role to the other major educational strategies. The following pedagogical concept of Visual Anatomical Imagery was another educational strategy used.

5.2.2 The use of Visual Anatomical Imagery

There was a strong visual theme that emerged across all the participants, as indicated in section 4.4.1 from page 87. The anatomy teachers gave three reasons for using the visual element: anatomy is an inherently visual discipline, the anatomy teachers themselves were visual learners and that the visual element helps to make learning easier.

The significant visual element in teaching anatomy can be explained in that the gross anatomy, the major branch of anatomy that was taught to physiotherapy students, is defined by sight. Gross anatomy is alternatively called topographic anatomy (Louw, Eizenberg, & Carmichael, 2009; Romanes, 1964) or macroscopic anatomy (Custers & ten Cate, 2011; Romanes, 1964). The practice of using gross anatomy gained credibility at the University of Bologna from the Renaissance (14th century) when cadavers were first dissected to teach human anatomy to medical students and was based on visualising anatomical structures (Blake, 1955), typically larger than 1mm in size (Drake et al., 2010; Louw et al., 2009; Romanes, 1964). The term 'gross' was probably chosen because the anatomists wanted to refer to something large or 'of conspicuous magnitude' (Online-Oxford-English-Dictionary, 2016) in the human body during dissection. Thus the definition of the type of anatomy taught to physiotherapy students accounts for the strong visual theme. Prosections were used in the current study to show the large anatomical structures that could be seen with a naked eye.

It is well-known that some teachers and students use the imagery system more strongly than others and may have an imagery advantage in learning (Clark & Paivio, 1991). A discipline dependent on vision, such as anatomy, might attract learners strong in visual imagery to become its teachers, who might in turn incorporate visual imagery into their instructional strategies for learning anatomy better. This advantage may make 'imagery gifted' physiotherapy students learn more from learning opportunities that augment textual descriptions with pictures and illustrations of the anatomical specimens than the less imagery gifted students. Many of the anatomy teachers in the current study identified themselves as 'visual learners' and mirrors others who have self-reported that they learnt better if there is a visual aspect (Mayer & Massa, 2003). There are reports that students may like visual learning material to complement textual material regardless of whether the visual component helps or is detrimental to learning (Serra & Dunlosky, 2010). Therefore, perceptions of visual imagery enhancing learning need to be confirmed with performances in examinations.

A significant portion of visual anatomical imagery had three-dimensional visuals, the spatial orientation of anatomical structures and how they were related to each other. The three-dimensional imagining of anatomical structures was promoted through seeing plastic anatomical models, seeing cadaveric specimens, seeing the surface anatomy on fellow students, using anatomical software with abilities to rotate anatomical structures and using ultrasonographic imagery to see anatomical structures moving beneath the skin. The former three activities required the students to move spatially around the anatomical structure, while the latter two activities used computer screens showing digital images being manipulated by the students. Computers were also extensively used and about half of the physiotherapy schools used computer-aided learning of anatomy in the USA (Reimer et al., 2013). There is some concern that representing three-dimensional anatomy on a two-dimensional computer screen is inferior to actually seeing the three-dimensional specimen and limits the haptic part of learning (Berube et al., 1999; Leung et al., 2006). Moreover, computer related imagery is weak on teaching anatomical variations and pathology (Berube et al., 1999; Willan & Humpherson, 1999a) and the actual size of human organs (Leung et al., 2006).

The multimedia principle, first proposed in the Paivio's Dual-Coding theory (Paivio, 1979, 1990, 2013) and that was later 'imported' and endorsed by the Cognitive-Load theory and the 4CID theory, states that learning is more effective if textual and visual imagery are used simultaneously and this is supported by a vigorous body of research (Mayer, 2014c), which indicates the optimum conditions where it may be so (Butcher, 2014). Each type of multimedia of the anatomical visual imagery discussed in Section 4.4.1.2 from page 88 was in real-time associated with written or printed verbal information, in alignment with the multimedia principle of the Cognitive-Load theory (Mayer, 2014a, 2014b; Paas & Sweller, 2014). Anatomy books had almost equal proportions of imagery vs text when the author reviewed the anatomy books in APPENDIX 16 on page 248. The list in APPENDIX 16 supports the view that the most preferred anatomy atlas books had the best photographs and pictures (Mattingly & Barnes, 1994). The anatomy teachers usually talked to the class while they were drawing simple anatomy sketches on the class whiteboard. The students usually talked to each other or with the teacher while they were viewing the pre-dissected cadaveric specimens. The physiotherapy students talked with their anatomy teachers about what anatomical structures they thought lay beneath the skin while learning surface anatomy during the Practical Anatomy Tutorials in 1st year.

The evidence for the multimedia principle has come from three main research outcomes: research based on memory (retention tests), deeper understanding (where students build mental models that can be applied to solve future problems) and how it affects positively or negatively other cognitive processes (Butcher, 2014). The strongest evidence based on effect sizes has been on deeper understanding (Hoffler & Schwartz, 2011; Mayer, 2001), with lesser effect sizes for being able to solve future problems and the least effect sizes for knowledge retention (Butcher, 2014). This evidence for the multimedia principle matchs some of the intended learning outcomes anticipated by the anatomy teachers in the current study, such as remembering anatomical knowledge and solving problems of patients requiring rich anatomical imagery. It should be noted that the evidence for effects of the multimedia principle came from controlled experiments, while the current study has more learning factors included and was not a controlled experiment.

5.2.3 The use of Kinaesthetic Anatomical Skills

There was a strong tactile and haptic anatomical multimedia theme across all the anatomy teachers, as was discussed in Section 4.4.2 on page 92. The use of tactile and haptic multimedia can be portrayed by the haptic learning of bones during the three undergraduate years. The students had to tactilely feel and manipulate the set of bones that they were personally loaned by their anatomy teachers. It was the norm for students to palpate the anatomical bones on themselves and on their classmates during the Practical Anatomy Tutorials in 1st year. Anatomical plastic models were also extensively used as tactile multimedia during the Practical Anatomy Tutorials and occasionally the students were allowed to manipulate and tug cadaveric specimens with their hands. The zenith of using tactile and haptic multimedia was when the physiotherapy students palpated, physically examined and treated healthy or injured bones and joints of patients during their 2nd and 3rd year clinical placements in hospitals. Teaching anatomy using many different physical formats is highly recommended for encouraging effective learning of anatomy (Rizzolo et al., 2006). Some of the clinical tasks requiring Kinaesthetic Anatomical Skills are using a goniometer (protractor for measuring joint angles), muscle testing and neurological examination (Mattingly & Barnes, 1994).

Prosections provided significant tactile stimulation for the students. Six of the eight schools of physiotherapy used prosections (pre-dissected cadaveric specimens) and was similar to the practice used in schools of physiotherapy in the USA (Latman & Lanier, 2001; Reimer et al., 2013) and Japan (Kawashiro et al., 2009), where prosections were more commonly used than physiotherapy students dissecting cadavers. The more time efficient prosections were preferred and used more frequently than students dissecting themselves because student dissections were more time consuming and depleted curricular time (Abu-Hijleh, 2010; Bandaranayake, 2010). The other reason could be that physiotherapists do not need dissection skills in their hospital careers and even some medical graduates do not have dissection skills (Abu-Hijleh, 2010) and do not need dissection experiences (Bandaranayake, 2010; McLachlan, Bligh, Bradley, & Searle, 2004; McLachlan & Regan De Bere, 2004). It must be noted that the need for dissection experiences by medical students has been hotly contested (Dyer & Thorndike, 2000; Pawlina & Lachman, 2004).

The current study used Practical Anatomy Tutorials as the main teaching activity for providing haptic multimedia and differed from the practice in the USA, where cadaveric-based teaching was their main teaching activity for haptic multimedia. The teaching of anatomy in the USA is heavily reliant on teacher-centred lecturing and cadaveric-based teaching (Abdur-Rahman, 2007; Berube et al., 1999; Latman & Lanier, 2001; Mattingly & Barnes, 1994; Melguizo et al., 2007; Prados, Melguizo, Vélez, & Hita, 2007; Reimer et al., 2013; Thomas et al., 2011). Australia too has moved from mainly using didactic lectures to using small-group practical classes to form the bulk of their teaching medium of physiotherapy education (McMeeken, 2007). The Anatomy Practical Tutorials, run in practical rooms and to a lesser extent in the anatomy cadaveric laboratory, were used as a vehicle for promoting the development of kinaesthetic anatomical knowledge and skills. The use of Anatomy Practical Tutorials in the UK could be traced back to the regulatory requirements by the HCPC as satisfying active-learning and student-centred learning (Bithell, 2007; HCPC-Training-Standards, 2009) and the pressure the CSP has placed on physiotherapy schools to run practical skills sessions/tutorials. Schools of physiotherapy wishing to achieve CSP Accreditation of Qualifying Programmes in Physiotherapy have to provide clear information on practical skill tutorials in terms of the number of tutorials, number and sizes of the practical rooms, number of students per tutorial, the number of academic staff that will supervise the practical skills tutorials and how the practical skills sessions will be examined (CSP-Accreditation-Supplement, 2016). The CSP and the predecessor of the HCPC has previously set a minimum requirement of 1,000 hours of ‘hand on’ clinical training in hospitals (Bithell, 2007).

There has been interest in better aligning the education of physiotherapy to the learning styles of students to enhance learning (Brown, Cosgriff, & French, 2008; Mayya & Rao, 2004; Milanese, Gordon, & Pellatt, 2013; Wessel et al., 2009; Zoghi et al., 2010) partly because of the desire to justify the significant costs of running physiotherapy education (Brown et al., 2008). There is a wide range of different types of inventories of learning styles and learning approaches (Al Maghraby & Alshami, 2013; Mayya & Rao, 2004; Milanese et al., 2013; Wessel et al., 2009; Zoghi et al., 2010) and Kolb’s Learning Style Inventory is the most commonly used in allied health literature (Brown et al., 2008). The VARK inventory, invented by Fleming for eliciting the instructional preferences of students, is of significant interest to the discussion of Kinaesthetic Anatomical Skills because one of the four learning styles (visual, aural, read/write and kinaesthetic) is the kinaesthetic learning style (P. Miller, 2001). The questionnaire of the VARK learning styles has well respected validity and reliability (Brown et al., 2008; Leite, Svinicki, & Shi, 2010). There are 24 possible permutations of the four types of styles because most people have multiple learning styles (Brown et al., 2008; Dissanayaka, 2014; Majeedkutty, Yang, Suppiah, & Lun., 2015; Rai & Khatri, 2014).

Four studies have examined the VARK learning styles of physiotherapy students. About 63% of physiotherapy students in Australia (Brown et al., 2008), 76% of physiotherapy students in Malaysia (Majeedkutty et al., 2015) and 92% of physiotherapy students in western India (Rai & Khatri, 2014) were classified as having kinaesthetic modes, either as single modes or as part of multiple modes, while the kinaesthetic style was the largest single group (percentage of multimodal groups containing a kinaesthetic learning style was not given) in Sri Lanka (Dissanayaka, 2014). The dominance of VARK-based kinaesthetic learning styles is common among health related students, such as occupational therapy and speech students (Brown et al., 2008), nursing students (Meehan-Andrews, 2009) and medical students (Kharb, Samanta, Jindal, & Singh, 2013; Lujan & DiCarlo, 2006). Students doing clinical placements in hospitals are more likely to prefer the kinaesthetic learning style (Majeedkutty et al., 2015).

Learning styles have been contentious because the learning styles are poorly distinguished from abilities and personalities, and has poor interactions with the rest of psychological literature (Sternberg & Zhang, 2001), which makes it hard to know what the learning styles actually mean at a conceptual level. Learning styles are generally poorly defined theoretical constructs and are said to function without the individual being aware of them (Sternberg & Zhang, 2001), in contrast to the current study where the research participants were aware of kinaesthetic styles. No link of the VARK learning styles to general intelligence was found in literature.

There was not an author in my literature search that identified haptic or kinaesthetic forms as qualifying as a form of multimedia, despite Mayer (Mayer, 2014b) acknowledging that multimedia may have more than two forms beyond verbal and visual formats. Some poor attempt was previously made to create a theory of schema in the long-term memory governing discrete motor skill learning (Schmidt, 1975), but lacked an explanation how children develop motor schema in the first place (Patrick, 1993) or how either a short-term or working memory processed information. The various authors on multimedia seem to take the perspective that multimedia learning only occurs from paper-based or computer-based learning environments, and ignores practical learning that can occur in a classroom laboratory or in work-based settings. There is a tendency among researchers to undervalue the non-visual components (environmental sounds, human actions, haptic and visceral sensations) of the nonverbal mental system and mostly describe the Dual-Coding theory as having just a verbal system and a visual system (Paivio, 1991). Although the non-visual components of the nonverbal mental system had been mentioned in earlier works of Paivio (Paivio, 1979), it was ignored by Cognitive-Load theory scholars. The ignoring of haptic input is reinforced by that most learning of basic sciences is about facts and not skills (T. M. Scott, 2000). The 4CID model makes a break from all the other learning theories based on the Cognitive-Load theory by emphasising skills and not just knowledge (Merriënboer, Clark, et al., 2002; Merriënboer et al., 1992; Merriënboer & Kirschner, 2013; Merriënboer, 1997). The simultaneous mix of verbal feedback during the teaching of haptic musculoskeletal skills in small groups is a potent form of learning (O'Dunn-Orto, Hartling, Campbell, & Oswald, 2012).

The teaching of kinaesthetic anatomical knowledge during the Practical Anatomy Tutorials was typically embedded in group learning or peep-to-peer learning, where students palpated each other and learnt anatomical knowledge from each other. A group of Cognitive-Load theory scholars have extended the Cognitive-Load theory meant for individual learning to cater for group learning through collaborative learning (F. Kirschner, Paas, & Kirschner, 2009, 2011; P. A. Kirschner, Kirschner, & Janssen, 2014). Collaborative learning works through the students pooling together their working memories (F. Kirschner et al., 2009; Ohtsubo, 2005), in what is referred to as the 'collective working memory effect' (F. Kirschner et al., 2011). Each individual has a working memory with a limited capacity and the collective working memory capacity to encode, store and retrieve schema and its automation using the working memories and long-term memories of many students is so much enhanced and larger when the many students work together on a task (P. A. Kirschner et al., 2014). Collaborative learning derived from the Cognitive-Load theory is said to be ineffective for straight forward recall of information, but works well for more complex tasks that are cognitively more demanding (F. Kirschner et al., 2009, 2011). Collaborative learning allows complex tasks to be mastered through a 'collective working memory effect' (F. Kirschner et al., 2011) and the knowledge used individually when the physiotherapy student qualifies as an autonomous physiotherapist. The descriptions of how groups learnt were too limited in the current study to allow for further interrogation of how information was shared, used, managed or regulated (P. A. Kirschner et al., 2014). Cognitive-Load theory based collaborative learning has some vulnerabilities in that it is uncertain what the optimum group size is for encouraging learning or how motivational or social factors influence the Cognitive-Load theory (P. A. Kirschner et al., 2014).

5.2.4 Strategies for teaching the clinical application of anatomy

The anatomy teachers used the fidelity principle, the variability principle and the completion principle of the 4CID model to teach the clinical physiotherapy application of anatomical knowledge. Anatomical knowledge related to the musculoskeletal system was the most frequently mentioned body system by the anatomy teachers in the study, as evidenced by APPENDIX 14 on page 245, and is in line with literature (Latman & Lanier, 2001; Mattingly & Barnes, 1994).

5.2.4.1 Fidelity principle

There is a persuading philosophy that anatomical learning should support physiotherapists working in clinical settings (Latman & Lanier, 2001) and is supported by the fidelity principle (Merriënboer & Kirschner, 2013). The fidelity principle of the 4CID and Cognitive-Load theories indicates that learning is better if students learn in similar environments to where they will work (Merriënboer & Kirschner, 2013). The principle describes a learning progression where students start by learning from textual descriptions of clinical cases, then learning from fellow students simulating patients in poor health and eventually learnt from real life patients (Merriënboer & Kirschner, 2013), and was similar to the current study in Section 4.4.3 on page 96. Anatomy teachers in the current study used historic or fictitious clinical stories/cases of conditions of patients during the 1st year to highlight the importance of anatomical knowledge. The use of many clinical cases is frequently used in the medical Problem-based learning pedagogy (Dolmans, De Grave, Wolfhagen, & van der Vleuten, 2005; Prince et al., 2003) and is associated with deeper desires and motivations for learning anatomy (Rizzolo et al., 2006). Fellow students pretended to be patients and occasionally healthy people were hired to pretend to be patients during the 1st year Practical Anatomy Tutorials, a commonly used physiotherapy teaching strategy (McLachlan & Patten, 2006). Many institutions use patients to teach medical students because they had a better description of their symptoms (O'Dunn-Orto et al., 2012). Eventually the students treated poorly patients in the clinical hospitals in largely the 2nd and 3rd years of Clinical student placements.

There are two main ways of arranging clinical placements: physiotherapy theory taught in parallel to clinical placements or physiotherapy theory taught during the first one and half years and then clinical placements in the later one and half years (Bithell, 2007). The eight physiotherapy schools assessed followed the parallel arrangement, where physiotherapy theory teaching sessions were running in parallel with the clinical placements.

In the past, anatomical theory for medical courses was taught during the first two years without clinical placements and was heavy on anatomical details that had little functional and clinical relevance, unlike in recent times (Abu-Hijleh, 2010; Turney, 2007). Fidelity is seen as improving the clinical relevance of anatomy. The linking of anatomy to clinical signs and symptoms is essential and should be through proper grounding of how anatomy leads to clinical presentations and not through superficial connections (Leong, 1999; Norman, 2000).

Fidelity in the 4CID theory comes in three varieties and can either be psychological fidelity (psychological mental states of students mimicking mental states while performing authentic tasks), functional fidelity (the training environments behaving as authentic environments) or physical fidelity (the physical environment similar to the authentic world environments) (Merriënboer & Kirschner, 2013), and the respective order reflects the relative importance between the three versions (Patrick, 1993). Extremely high fidelity hinders learning in novice learners (Harp & Mayer, 1998; Mayer, Heiser, & Lonn, 2001) and underscores the need to gradually increase the complexity of fidelity (Merriënboer & Kirschner, 2013), as was done in the current study.

5.2.4.2 Variability principle

According to the variability principle of the 4CID and Cognitive-Load theories, robust learning is believed to promoted when a student is exposed to a wide variation of life situations (Merriënboer & Kirschner, 2013). The physiotherapy students were encouraged to palpate as many different bodies as possible during the Practical Anatomy Tutorials. Physiotherapy students went to many different clinical rotations in the 2nd and 3rd years and these rotations ranged from musculoskeletal, cardiorespiratory to neurological clinical placements, where they saw as many different conditions as possible. Most of the variation came in the later stages of learning, i.e. 2nd and 3rd years.

Learning through variable practice is thought to occur through a process of inductive learning, where students construct more general cognitive schema to account for the concrete variable practice (Merriënboer & Kirschner, 2013), especially high contextual interference (De Croock et al., 1998; De Croock & Merriënboer, 2007; Helsdingen, van Gog, & Merriënboer, 2011a, 2011b). Variable tasks are among the most popular ways of promoting learning transfer that has backing evidence (Cormier & Hagman, 1987).

Multimedia with a high variability, although initially difficult to learn (Merriënboer & Kester, 2014), promotes more effective transfer of problem solving abilities in the long run (Corbalan, Kester, & Merriënboer, 2009; Paas & Merriënboer, 1994a), especially where the contextual background is more varied (De Croock et al., 1998; De Croock & Merriënboer, 2007; Merriënboer, Schuurman, De Croock, & Paas, 2002). Novice learners performing highly variable tasks without teacher guidance (like what happened during the implicit learning of anatomy during the student placements), is not recommended (Merriënboer & Kirschner, 2013). 'Transfer' is curtailed if the solution is too strongly destined to a particular context and encouraging variability of contexts and problems promotes true knowledge 'transfer' (Norman, 2000).

Variability of practice can be promoted through altering time allocated for performing tasks, how the task is reported back, varying familiarity of the task, varying the skills required to complete a task or changing the contextual setting (Merriënboer & Kirschner, 2013). Variability induced by a randomly arranged practice schedule is strongly associated with good transfer of problem solving abilities (Merriënboer & Kester, 2014).

5.2.4.3 Completion principle

According to the completion principle, learners learn better if they are initially given worked examples, then partially workout examples and eventually are given full problems to solve, rather than perpetually giving the students worked examples or conventional unworked problems (Renkl, 2014). In the current study, the anatomy teachers initially gave the learners near complete mini clinical scenarios or past medical situations of stories experienced by the anatomy teachers during the 1st year, then partially worked problems. Eventually by the 3rd Year, the students were expected to solve full problems on patients on their own because the students had acquired more sophisticated anatomical schemas to help them solve anatomical problems. The completion principle also requires the curriculum to be spirally designed and set out in increasing levels of complexity as the automation of tasks becomes more subconscious and efficient (Sweller et al., 1998), just as the fading guidance principle, and contributes to the spiral learning strategy. Problems based on the completion strategy are easier to solve than conventional problems (Sweller et al., 1998) and assist the learner to solve similar problems in future (Renkl et al., 2004; Renkl & Atkinson, 2003). Instruction based on the completion strategy benefits novice learners more than expert learners (R. K. Atkinson, Derry, Renkl, & Wortham, 2000) and the undergraduate physiotherapy students ought to benefit from the completion principle more than qualified physiotherapists attending anatomy professional development courses.

5.2.5 Using anatomical principles for metacognition

The fifth major pedagogical concept was that anatomy teachers taught their physiotherapy students to focus on anatomical principles, as a way of coping with the voluminous ‘index knowledge’ of anatomy (please Section 4.5.2.2 from page 104) within the narrow time constraints (please refer to Section 4.3.2 from page 84). The teachers of anatomy for physiotherapy in the USA also faced a high volume of content and insufficient time and responded by teaching “essentials” p.726 (Mattingly & Barnes, 1994). Similar concerns over increasing anatomical content in medical courses against shrinking available teaching time for anatomy have been expressed before (Turney, 2007) and resulted in ‘information overload’ (p.5) (J. Anderson & Graham, 1980). Overloaded medical curricula led to the setting up of shorter anatomical courses for medical courses (Bergman et al., 2011; Drake, Lowrie, & Prewitt, 2002; Heylings, 2002; Leong, 1999; Paalman, 2000; Rizzolo et al., 2006; T. M. Scott, 1993; Terrell, 2006). 70% of medical teachers at an international academic conference reported that teaching time for anatomy was reduced at their last major revisions of their medical curriculums (Pawlina, 2009). An increase in self-study time at home might mitigate the reduction in scheduled teaching time (Bergman et al., 2011). Reduced content and low-density teaching sessions were recommended as a way of dealing with an overloaded curriculum in restricted time allocations (Russell et al., 1984).

Several reasons are responsible for the decline in teaching time for anatomy. The increase in teaching knowledge and teaching time for biomedical science has been at the expense of reducing teaching time for anatomy (Abu-Hijleh, Habbal, Moqattash, & Harris, 1995; Abu-Hijleh, 2010; Paalman, 2000; Rizzolo et al., 2006). The practice of allocating more time for teaching integrated clinical knowledge resulted in less available time for teaching anatomy (Berns et al., 2001). The decline in recognition of the comprehensive coverage philosophy in teaching anatomy, where all the voluminous anatomy content is taught in a time consuming manner, gave rise to knowledge that was too short-lived to be applied to future clinical situations (Rizzolo et al., 2006). The complaints on the decline of the role of anatomy have been driven by anatomy teachers protecting their interests who typically make commentaries in journal papers (Cahill, Leonard, & Marks, 2000; Gogalniceanu et al., 2010; McCuskey et al., 2005; Monkhouse, 1992; Norman, 2000; Older, 2004; Satyapal & Henneberg, 1997; Sugand, Abrahams, & Khurana, 2010). The concerns of anatomy teachers have triggered surveys to confirm their fears of the decline in anatomical teaching time for medical courses (de Bere & Mattick, 2010; Drake et al., 2002; Drake, McBride, Lachman, & Pawlina, 2009; Gartner, 2003; Gogalniceanu, O’Connor, & Raftery, 2009; Heylings, 2002; Willan & Humpherson, 1999b) and for physiotherapy in the USA (Abdur-Rahman, 2007; Armstrong & Rosser, 1996; Latman &

Lanier, 2001; Mattingly & Barnes, 1994; Reimer et al., 2013). The reduction in teaching time for anatomy is unfortunate because cumulative learning is strongly associated with increased time spent learning any given subject (Baddeley et al., 2009).

'Anatomical principles' are recurring concepts or phenomenon that can be generalised to many more anatomical situations (Louw et al., 2009). Principles of basic sciences are advantageous because they last longer in the long-term memory than facts (T. M. Scott, 2000). Two types of anatomical principles emerged from the study: principles of how anatomical structures were arranged and principles on how anatomical structures functioned or lacked function due to impairments. Anatomy teachers can get a better grasp of what these two anatomy principles are by looking at a list of technical anatomical principles compiled by (Louw et al., 2009), which were intended for all health students, including physiotherapy students. I have compiled a list of anatomical principles in APPENDIX 17 on page 249 that I thought would be of interest to the physiotherapy profession. APPENDIX 17 is largely based on anatomical principles by Louw and his colleagues (Louw et al., 2009) related to the musculoskeletal system and to a lesser extent on anatomical principles described by anatomy teachers in the current thesis.

The idea of teaching general anatomy principles before the more specific anatomical principles is an old one. It is the norm among the more popular anatomy textbooks for physiotherapy students (Cael, 2010; D. B. Jenkins, 2008; Moffat & Mottram, 1979; Palastanga, Field, & Soamas, 2000; Porter, 2008; Singh, 2006) and medical students (Drake et al., 2010; K. Moore et al., 2013; Sinnatamby, 2006; Snell, 1995; Standring, 2008) to start with an introductory first chapter describing general anatomy principles. Anatomy teachers usually give a preliminary threadbare introductory teaching session on the general anatomy principles. More teaching effort and time ought to be set aside for teaching general anatomy principles that lay a more solid foundation for learning anatomy (Louw et al., 2009).

There is more profit in teaching the principles of anatomy than spending more time going through an 'index knowledge' of anatomy because concepts are easier to remember (Conway et al., 1991; T. M. Scott, 2000) and are more likely to integrate into existing schema (Bahrick, 1992) and housed in the permastore (Conway et al., 1991) than names. The drive towards learning anatomical principles or concepts is supported by the 'reconstruction hypothesis', which indicates that most memories are actually reconstructed during remembering (Bartlett, 1932), although the high retention rate of names challenges that view (Conway et al., 1991). Reconstructing concepts is easier than for verbatim information, such as names, and resembles problem solving rather than reproducing information (Neisser, 1984). It is doubtful if there are memories for specific experiences at all (Loftus & Loftus, 1980).

Anatomical principles in the current study were aimed at creating metacognitive schemata that helped the students to benchmark anatomical knowledge. Benchmarking cognition helped the students to self-regulate their primary cognition. In this thesis, primary cognition will be defined as the cognition that causes the intrinsic load (explained in Section 2.3.2.4.3.2 on page 32) and the secondary cognition being the metacognition of the primary cognition. Metacognition is a higher order self-supervision of the primary cognitive task and helps a student to best strategise the solving of a cognition problem, oversee the understanding of a learning task and how well the task is successfully completed (Schnotz & Kürschner, 2007). The two benchmarking metacognition anatomical schema encouraged among the physiotherapy students by the anatomy teachers were schema for generic organisation of anatomical structures and predicting functional abilities (or lack of function due to impairment) of anatomical structures on patients. The two types of anatomical schema could play three different roles: benchmarking cognitive results, answering specific questions with no answers and synthesising forgotten information.

The anatomy teachers taught schema of the generic organisation of anatomical structures that were rules on how the anatomical structures were arranged in the human body and the same rules could be applied to many more places in the body. The other type of benchmarking schemata predicted the functional abilities (or lack of) of anatomical structures on patients. The results of primary cognition could be compared with the benchmarking schemata of generic anatomical organisation or schemata predicting functional outcome, and the differences used to self-regulate their primary cognitions. If there was a difference, metacognition could redirect the cognition system to re-start the analysis of the primary cognition again to see if there was a processing error or try and account for the difference. If there is a suitable explanation of the difference, the schema information in the long-term could be altered to accommodate the difference.

Secondly, the more general schema are usually recruited when a student lacks specific schema to answer specific questions (Neisser, 1984; Renkl et al., 2004), and both the schema on the generic organisation and functional abilities could play that role. Teaching general anatomical principles was thought to arm the students with the “necessary intellectual tools” p.377 on how to find specific anatomical information better (Louw et al., 2009). Thirdly, the same generic benchmarking and functional schema predicting information could also potentially play another metacognitive role of reconstructing the forgotten schema required to solve anatomical problems being addressed by the primary cognition. A significant portion of the anatomical knowledge was stored temporarily in the long-term memory and forgetting was considered normal by the anatomy teachers. The metacognition process could realise that some information needed to solve a particular anatomical problem is missing, and then redirects the cognition machinery using available generic anatomical schema to rebuild or reconstruct missing or forgotten schema, before going back to solve the primary cognition problem. Although a specific portion of the 'index anatomical knowledge' could help rebuild the missing schema, generic benchmarking and functional predicting schema have a more universal application, are more potent and makes them more likely to be frequently used, just as how (Louw et al., 2009) described a more generalisable role of anatomical principles. The concept of more universal generic schemata is what the founder of the Cognitive-Load theory described when he said that the generic schema on trees can be applied on "potentially infinite variety of objects called trees" pp 296, in contrast to schema on one particular tree (Sweller, 1994). The generic anatomical schema are similar to generisable problem solving schema used for solving geometry problems (Koedinger & Anderson, 1990) and word-based problems (Low & Over, 1990) in that they can be applied across a wider spectrum of problems.

At a theoretical level, the use of anatomical principles for benchmarking could be explained using the germane load of the Cognitive-Load theory. The germane load is at a metacognitive level and is the cognitive load due to the student cognitively managing the intrinsic cognitive load, where students undergo a secondary higher level thinking about their primary thinking or cognition (Schnotz & Kürschner, 2007). Up until 1994, the consensus among Cognitive-Load theory scholars was that lowering the cognitive load was an essential educational target for promoting effective learning (Paas & Merriënboer, 1994a). They discovered that an increase in a new 'good' cognitive load actually enhanced future learning by improving cognitive schemata and was called the germane cognitive load (Sweller et al., 1998). Teachers were encouraged to increase the germane cognitive load as much as possible to below the maximal capacity of the working memory (Ayres & Sweller, 2005).

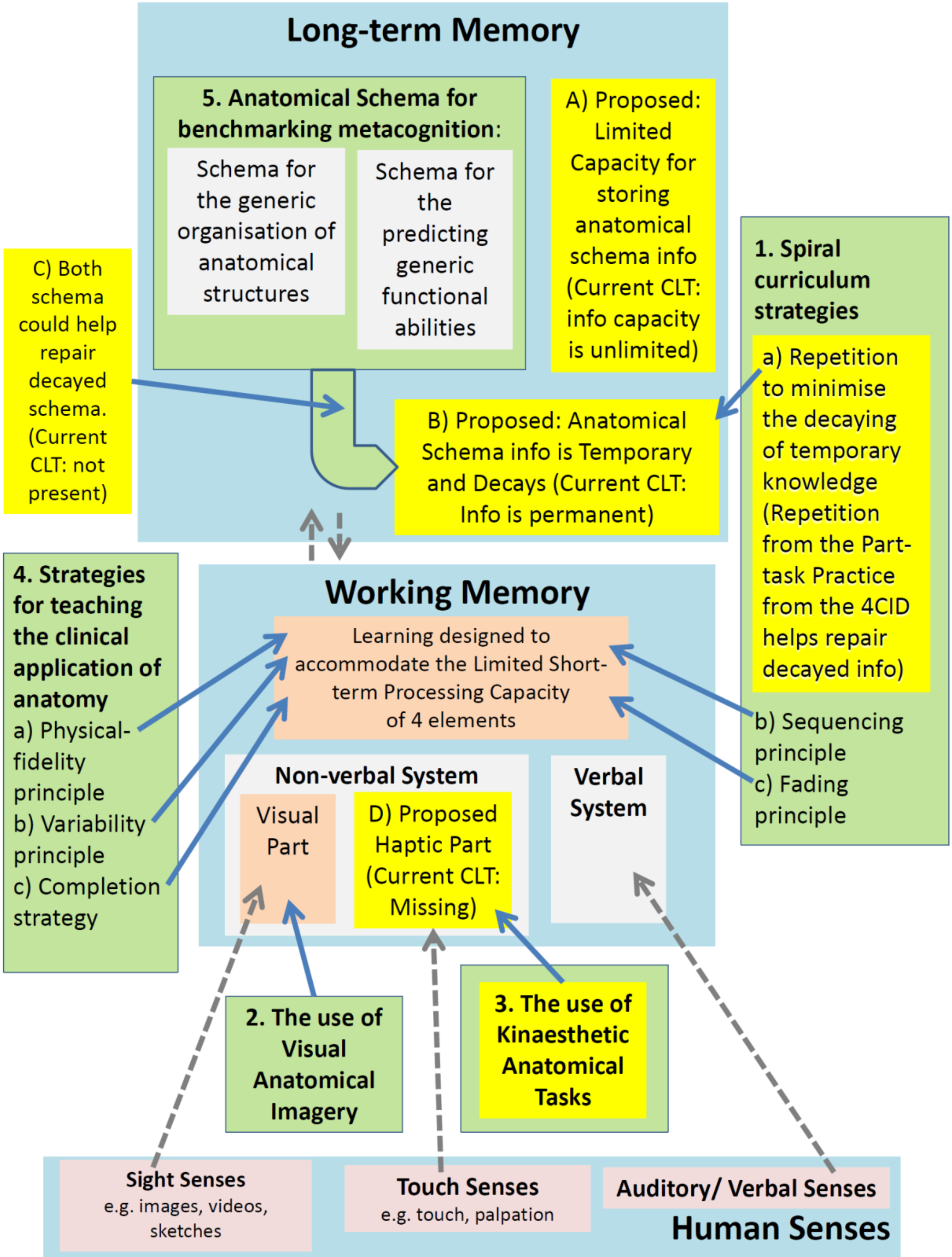
Some types of germane cognition are more efficient than others in generating the same metacognition schemata. Therefore, teachers are encouraged to minimise the germane cognitive load by using more efficient germane cognition, so as to free up cognitive resources for the intrinsic cognitive load or for additional germane loads. The anatomy teachers minimised the germane load by providing information that would make it easier to compile schema that would help to identify anatomical patterns and to be able to predict function. The ultimate aim of the germane cognitive load is to create very useful schema. Some schema requires many years of experience to create, for example chess grandmasters took about ten years to create complex schema that novice chess players did not have (Amidzic et al., 2001; Chase & Simon, 1973). The eight anatomy teachers who participated in the study had more extensive anatomical experiences of typically over ten years. The teachers had time to make succinct and highly efficient schema that students could not make on their own during their short undergraduate time. Thus the anatomy teachers helped to make the learning of the students more efficient and quicker.

Explicit encouragement of using metacognition strategies ought to be encouraged more (Cutting & Saks, 2012) and should extend to the explicit motivation of students on the use of generic anatomy principles. Metacognition can be facilitated by making the teachers and students think aloud when they are thinking through problems or making decisions in classrooms (Cutting & Saks, 2012), as was done in teasing apart the role of basic sciences during the clinical reasoning of clinicians through 'thinking aloud' methodologies (Boshuizen & Schmidt, 1990; Patel & Groen, 1986).

5.2.6 The relationships between the five dominant pedagogical concepts

The second objective of the study, listed in Section 2.4.2 on page 38, was to describe the relationships and dynamics between the major pedagogical concepts. The relationships and dynamics between the major pedagogical concepts and how they relate to the Cognitive-Load and 4CID theoretical frameworks are illustrated by the FIGURE 14 on the next page.

Figure 14: The relationships between the five dominant pedagogical concepts



The diagram shows how information starts from the senses, then moves to the verbal and nonverbal components of the working memory, and finally reaches the long-term memory to be stored as anatomical schema. The five dominant pedagogical concepts are shown in green boxes and are numbered from 1-5. The four deviations from the CLT and 4CID theoretical frameworks are indicated in yellow boxes and are lettered from A-D and the current positions of the two theories are in brackets. A new version of the current Cognitive-Load theory is proposed and fully described in Section 6.2.2 on page 152. The Visual Anatomical Imagery and Kinaesthetic Anatomical Skills contributed to the visual and haptic elements respectively of the non-verbal system of the working memory. Strategies for clinical anatomy and the last two aspects of the spiral curriculum were streamlined to be within the confines of the limited processing capacity of the working memory. The anatomical schema for benchmarking metacognition helped to restore decaying information in the long-term memory. The repetition element of the spiral curriculum also helped to reinforce decaying information in the long-term memory.

5.3 Discussion Conclusion

The five dominant pedagogical concepts and their relationships have been explained using the 4CID and Cognitive-Load theoretical frameworks. The five main pedagogical concepts have been accepted as good pedagogical practice in medical education. More frequent reviews of smaller blocks of information, cumulative review and cumulative assessment of previous teaching (collectively as part of the sequence principle), learning anchored in clinical contexts (clinical fidelity principle) and variation in problems and cases (clinical variability principle) are encouraged teaching techniques in medical education (Cutting & Saks, 2012). Gross anatomy teaching based on 'hands-on' teaching (use of Kinaesthetic Anatomical Skills principle) and 'eyes-on' (Visual Anatomical Imagery principle) are highly respected and used in medical education (Paalman, 2000). The next chapter will propose recommendations to strengthen the use of the five dominant pedagogical concepts.

6 New knowledge, Recommendations, Personal Reflections and Conclusion Chapter

6.1 Introduction

This chapter will describe the new knowledge that emerged from the study in two avenues. Firstly, the direction of the current thesis was guided by the research objectives and answering the research objectives created new pedagogical knowledge on how anatomy for physiotherapy is taught in the UK. Secondly, fresh perspectives were discovered while using the Cognitive-Load theory and grounded theory methodology and will be used to propose new versions of the two respective theories. There are influential groups of people who have a significant bearing on how the five dominant pedagogical concepts are going to be used and recommendations will be made to the Anatomy Theme Leads for physiotherapy, anatomy-teachers-for-physiotherapy and the CSP. Lastly, the chapter will reflect on the impact of the findings of this thesis on my teaching practice, how the EdD thesis has transformed me and potential future career implications.

6.2 Original new contributions to knowledge

6.2.1 Original new pedagogical contributions to knowledge

The current study was in response to the lack of empirical studies offering pedagogical guidance for teaching anatomy for physiotherapy in the UK, as was the case in the USA prior to 1994 (Mattingly & Barnes, 1994), a 30 year lag. Most certainly, there is no doctoral thesis pertaining to anatomy for physiotherapy in the UK (EThOS, 2016). Anatomical pedagogy for physiotherapy around the world is typically described in practical and activity terms in the USA (Abdur-Rahman, 2007; Berube et al., 1999; Latman & Lanier, 2001; Mattingly & Barnes, 1994; Reimer et al., 2013; Thomas et al., 2011) and in Europe (Melguizo et al., 2007; Prados et al., 2007). Anatomy teachers for physiotherapy typically do well in proving how useful a certain type of learning resource is (Latman & Lanier, 2001), but forego proving which combination of learning resources and their underpinning pedagogical philosophy or theoretical strategy are effective.

The situation is similar to advocating for certain individual instruments to create good music and not how certain instruments are combined, their timing and intensity, and the overarching strategy for using the instruments. Moreover, the majority of published papers in this area were quantitative studies with little engagement with perspectives of theoretical strategies. The current study is probably the first to take a qualitative view in researching the teaching of anatomy for physiotherapy and bridges a link with existing cognition theoretical frameworks. Pedagogical theories have the advantage of reducing the likelihood of improving learning through trial and error and aims to make more efficient use of learning opportunities and resources (Terrell, 2006).

New pedagogical knowledge developed by this thesis (in the form of the five dominant pedagogical concepts) was in response to the five research objectives set out in Section 2.4.2 on page 38 and are summarised in TABLE 13 on the next page. The first and most important objective generated the five dominant pedagogical concepts. The second objective considered which of the dominant pedagogical concepts guided the use of teaching resources, while the third objective examined which of the dominant pedagogical concepts were affecting the planning, delivery, assessment and evaluation of teaching and learning. The fourth objective led to the revealing of the relationships and dynamics among the five dominant pedagogical concepts that were earlier described in FIGURE 14 on page 148. The fifth objective sought to describe pedagogical concepts that helped their students to learn anatomy in the long run of five years after graduation. In practice, the anatomy teachers only had first-hand experience of the learning effects during the 1st year of undergraduate programmes in all the physiotherapy schools, except for Kelly's school, and rated successfully learning of anatomy as passing the end of 1st year anatomy examinations. Consequently, the anatomy teachers were not able to review and evaluate the success of their teaching of anatomy over the three undergraduate years and let alone five years after graduation.

Table 13: Fulfilment of the planned research objectives

The objectives of the study were to find:	Results to the objectives	Comment
1. The main pedagogical concepts of teaching and learning anatomy for physiotherapy	The five most dominant teaching strategies i. Spiral curriculum strategies ii. The use of Visual Anatomical Imagery iii. The use of Kinaesthetic Anatomical Skills iv. Strategies for teaching the clinical application of anatomy v. Using anatomical principles for metacognition	Achieved
2. Which of the main pedagogical concepts were used for influencing the use of the teaching resources, such as the quality and number of teaching, technical and administrative staff, learning resources, time resources and use of buildings	i. The use of Visual Anatomical Imagery ii. The use of Kinaesthetic Anatomical Skills iii. Strategies for teaching the clinical application of anatomy	Achieved
3. Which of the main pedagogical concepts were used for influencing the planning, delivery, assessment and evaluation of teaching and learning anatomy for physiotherapy	The five most dominant teaching strategies i. Spiral curriculum strategies i. The use of Visual Anatomical Imagery ii. The use of Kinaesthetic Anatomical Skills iii. Strategies for teaching the clinical application of anatomy iv. Using anatomical principles for metacognition	Achieved
4. The relationships and dynamics between the main pedagogical concepts used by anatomy-teachers-for-physiotherapy	Were discussed in FIGURE 14 in section 5.2.6 on page 147	Achieved
5. The standards that anatomy-teachers-for-physiotherapy use to judge whether their teaching of anatomy will be effective in the professional practice of graduates five years after graduation	The teaching influence of the anatomy-teachers-for-physiotherapy typically did not exceed the 1st year of the undergraduate physiotherapy degree and could not ascertain learning effects beyond the 1st year	Not achieved

6.2.2 Original new contributions to the Cognitive-Load theoretical framework

The Cognitive-Load theory is one of the most widely used cognitive theories for learning (Gerjets et al., 2009; Moreno & Park, 2010) and can be made more robust by being continually scrutinised and improved. The current study found three possible fundamental deviations from the Cognitive-Load theory. Firstly, information in the long-term memory was temporary and transitory in nature in the earlier stages of learning of novice anatomy learners and contradicted the view of the Cognitive-Load theory that information in the long-term memory is permanent (Paas & Sweller, 2014; Simon & Gilmartin, 1973). The temporary information was made more permanent by frequently revisiting and reinforcing the temporary information through the spiral curriculum. The temporal nature of information requires teaching sessions based on the Cognitive-Load theory to teach the same or similar concept repeatedly over time, rather just once and assume that the knowledge is would be permanent. The chess grandmasters that were used to construct the Cognitive-Load theory frequently played chess almost on a daily basis for at least a decade (Simon & Chase, 1973) and had had an intense and prolonged period of being able to repeat and reinforce their knowledge. The proposed amended Cognitive-Load theory then applies to the 'Ebbinghaus: curve of forgetting' period on the forgetting timeline after the initial learning, in contrast to the current Cognitive-Load theory, which applies to the stable permastore stage. The shift from permanence of information in the Cognitive-Load and 4CID theories then requires opting for either the lost information or the 'seemingly forgotten' information positions. While for everyday living it may not matter having lost information or 'seemingly forgotten' information (Loftus & Loftus, 1980), it is important for a cognitive theory to choose sides because it may provide new paths of research into the Cognitive-Load and 4CID theories.

Secondly, the current study found that the capacity of the long-term memory of novice learners at an earlier stage was limited and the students could not cope with the volume of anatomical content they were expected to learn, as indicated in Section 4.3.1 on page 84. The long-term memory capacity differed from the traditional Cognitive-Load theory, where the information capacity of the long-term memory is practically unlimited (Paas & Sweller, 2014; Young et al., 2014). The Cognitive-Load theory had hoped that by having a limited processor, the working memory, would have slowly fed manageable information into the long-term memory to handle, but it was not supported by the current study. It could be that the anatomy content being taught was too voluminous (please see section 4.4.1) for the early stages of novice learners.

Thirdly, a haptic extension to the current Cognitive-Load theory is being proposed and is labelled D in FIGURE 14 on page 147. Cognitive-Load theory scholars ought to consider the processing of haptic multimedia as equally important as the processing of visual multimedia, as indicated by Paivio (Paivio, 1979), but is frequently ignored. Opening up the help that haptic multimedia could give to learning could change the way some teaching and learning is conducted to a more practical way. With practical learning, students are more likely to be engaged and motivated to learn (Adibi, Hasani, Ashoorioun, Sadrearhami, & Monajemi, 2007; Yiou & Goodenough, 2006), although it could be more costly to run and pose higher safety risks for students (Gangata, Ntaba, et al., 2010; McLachlan et al., 2004; McLachlan & Patten, 2006).

6.2.3 New contributions to the Grounded Theory methodology

The epistemological framework of radical constructivism best fitted the intended research major concepts that anatomy-teachers-for-physiotherapy used for best anatomy teaching practice and was extensively discussed in earlier passed EdD modules in APPENDIX 28 on page 264. My extensive search for a suitable methodology boiled down to grounded theory methodology, which was chosen for several reasons elaborated in APPENDIX 28 too. The difficulty I had was that I could not find a single research paper that used both the epistemology of radical constructivism and a research methodology of grounded theory methodology. I proposed a set of new practical suggestions for the research methods noted in APPENDIX 28 to satisfy both the radical constructivism and grounded theory methodology theoretical frameworks. The novel practical adjustments may benefit future researchers whose research may benefit from or require both the radical constructivism and grounded theory methodology theoretical frameworks.

6.3 Recommendations

There are a number of recommendations that will be made as a follow-up of using the 4CID and Cognitive-Load theories in interpreting the results of the current study. The recommendations have been arranged and organised according to whom they are being addressed to. TABLE 14 on the next two pages shows how the recommendations to the Anatomy Theme Leads for physiotherapy, anatomy-teachers-for-physiotherapy and the CSP are spread and derived from the five dominant pedagogical concepts.

Table 14: Summary of recommendations

Recommendations based on the five dominant pedagogical concepts from the Discussion Chapter			
	For the Anatomy Theme Leads for physiotherapy	*For anatomy-teachers-for-physiotherapy*	*For the Chartered Society of Physiotherapy*
i. Spiral curriculum strategies	i. To manage the spiral curriculum in terms of the sequencing of teaching content, how the fading principle could be applied to the levels of teaching support for students and offer several opportunities on how forgotten anatomical knowledge could be refreshed and reinforced in later sessions. ii. Ensure good handovers of the 'anatomy teaching baton' from one teacher of anatomy to the other		
ii. The use of Visual Anatomical Imagery	i. Anatomy Theme Leads could be encouraged to lead the systematic and strategic incorporation of visual imagery into teaching anatomy using appropriate anatomical learning aids		
iii. The use of Kinaesthetic Anatomical Skills	i. Managing and coordinating the learning of tactile and palpation skills through using practical tutorials, dissected cadaveric specimens and the physical examinations of patients		
iv. Strategies for teaching the clinical application of anatomy	i. Managing the clinical application of the fidelity principle and variability into all the anatomy learning activities ii. Introducing explicit anatomy teaching into the later clinical years		
v. Using anatomical principles for metacogniti on		i. Compiling general anatomical principles for physiotherapy in a systematic and comprehensive way	

Other recommendations addressing problems raised in the Results Chapter			
	For the Anatomy Theme Leads	*For anatomy-teachers-for-physiotherapy*	*For the Chartered Society of Physiotherapy*
vi. Lack of minimum standards			i. The CSP could set the minimum anatomical knowledge standards for students
viii. Lack of a supportive national academic community			i. The need to set up the Society of Anatomy-teachers-for-physiotherapy
vii. Ways of reducing the extraneous cognitive load on students		i. The need for a unified anatomy textbook for physiotherapy	

6.3.1 Recommendations for the Anatomy Theme Leads

6.3.1.1 Appointment of Anatomy Theme Leads

A number of problems in teaching anatomy for physiotherapy stem from lack of anatomy leadership, due in part to modularisation of undergraduate physiotherapy courses in the UK, and could be addressed by appointing an Anatomy Theme Lead. The Anatomy Theme Lead could be responsible for managing and leading all the undergraduate and postgraduate anatomy teaching in the school of physiotherapy, similar to Kelly's anatomical leadership strategies discussed in Section 4.5.4.3.2 from page 113. The Physiotherapy degree Programme Lead, who is accountable for running the physiotherapy degree programme, could appoint an Anatomy Theme Lead who is a registered physiotherapist. The Physiotherapy degree Programme Lead has to satisfy the requirements of the CSP, HCPC, university, the NHS, Quality Assurance Agency for Higher Education (Quality-Assurance-Agency-for-Higher-Education, 2001), government departments of health and education and a host of other regulatory bodies.

It could be argued that the current typical teaching suffers from being too modularised and anatomy teachers have a poor awareness of what is happening in the other modules that teach anatomy, as discussed earlier in Section 4.5.4.3.1 from page 112. The curricula for BSc in Physiotherapy degrees in the UK are typically arranged on a modular credit system, which cumulatively builds towards 360 credits by the end of a three year programme and where each credit recognises ten hours of student effort (Bithell, 2007). There is a major drive of ensuring comparability and harmonisation of higher education among the 47 European countries through a system of modular credits, which was flamed into action by the Declaration of Bologna (Bologna Secretariat, 1999). The screws of the Bologna process are continually being tightened and modified through biannual various inter-governmental meetings (Bologna Secretariat, 2001, 2003, 2005, 2007, 2009, 2010, 2012, 2015) and are changing the organisation of physiotherapy undergraduate learning (Cochran-Smith, 2005; Melguizo et al., 2007). Anatomical curricula spread across many modules could benefit from an Anatomy Theme Lead who could foster continuity of anatomical learning across the many modules, especially as the Bologna process is still ongoing.

Concepts of the spiral curriculum extend beyond the responsibilities of single disciplines/departments (Kabara, 1972) and the teaching of anatomy across many physiotherapy disciplines by many teachers in the university tutorials and clinical hospitals requires an overarching anatomy leadership that extends vertically and horizontally across the physiotherapy school. If a subject does not have an identifiable expert in a university, the subject gradually vanishes from the curriculum (T. M. Scott, 2000) because curricula time, funding and infrastructural space are always being contested for. A visible subject expert may make it easier for students to seek help (T. M. Scott, 2000), like physiotherapy students in clinical placements seeking for anatomical knowledge and learning aids to help them learn anatomy.

6.3.1.2 Roles of the Anatomy Theme Leads

There are broader anatomy curricular design issues that Anatomy Theme Leads could use to promote continuity and cohesion across anatomy modules. These may include designing timetables, managing anatomical training during clinical placements, managing the numerous clinical specialists and the Clinical Student Placement Supervisors in different settings. It could be helpful if the Anatomy Theme Leads could work towards setting measures of successful learning of anatomy over the three undergraduate years (which were lacking from the current study because anatomy teachers typically were not aware of what anatomy content was taught during the second and third years, as indicated in Section **4.5.4.3.1** from page **112**), the philosophy underpinning it and how that success could be evaluated at the end of the three years. In terms of documentation, a clear layout of all the anatomy learning outcomes could be mapped out covering, not only 1st year anatomical teaching, but also for formally teaching anatomy during the 2nd and 3rd year modules for clinical physiotherapy specialties, such as musculoskeletal, cardiorespiratory and neurology, and clinical placements run by the Clinical Student Placement Supervisors. The learning objectives could help improve awareness of anatomical content taught by other anatomy teachers. The Anatomy Theme Lead could help modify the teaching activities after reviewing the annual feedback from staff and students, and on how well the students have been learning, while factoring in the local practical constraints. It is common for different physiotherapy schools to have varying levels of resources at their disposal for teaching anatomy (Leung et al., 2006).

The Anatomy Theme Lead could manage the over-arching spiral curriculum in terms of the sequencing of teaching content, how the fading principle could be applied to gradually decreasing levels of teaching support for students and offer several opportunities on how forgotten anatomical knowledge could be refreshed and reinforced in later sessions. There is a need for anatomy teaching for physiotherapy to be more intentional and proactive in sequencing anatomical content rather than simply adopting the established historical sequence (Khan et al., 2015; Latman & Lanier, 2001; Reimer et al., 2013). Fair consideration could be given for alternative sequences that are evidence based. A well-crafted spiral curriculum could have good handovers of the ‘anatomy teaching baton’ among the various teachers teaching anatomy to ensure continuity and should encourage regular meetings among them. Communication tends to be poor between basic scientists and clinical faculty (T. M. Scott, 2000). Awareness of what other teachers are teaching in a degree programme is the second of the eleven stages of a continuum of working towards integration of a medical curriculum (Brauer & Ferguson, 2015). Academic teachers have a special role to play in supporting Clinical Placement Student Supervisors with learning outcomes of what students are expected to learn during placements and how they will be assessed (Bithell, 2007). The Anatomy Theme Leads could provide guidance to the Clinical Student Placement Supervisors on what anatomical knowledge and skills the physiotherapy students were expected to learn, the forms of acceptable assessments and broader pedagogical strategies they may use.

Anatomy Theme Leads would be encouraged to incorporate visual imagery in teaching anatomy to physiotherapy students for the cognitive architecture to generate more profound learning. All the anatomy teachers interviewed in the current study strongly recommended the inclusion of visual imagery to promote effective learning of anatomy, an idea supported by the multimedia principle of the Cognitive-Load and 4CID theories (Merriënboer & Kester, 2014; Merriënboer, 1997; Paas & Sweller, 2014; Sweller & Chandler, 1994). Anatomy Theme Leads will require significant financial resources to incorporate some types of visual imagery into their teaching. Pictorial rich mobile phone and desktop anatomical software, plastic anatomical models of body parts and ultrasonographic equipment and the setting up and running of cadaveric laboratories will require significant budgetary commitments. However, some types will be relatively inexpensive, such as visually rich anatomy textbooks, sketching on whiteboard, surface anatomy palpation on students and using visual multimedia on social websites. The success of using visual imagery will hinge on how well the images complement the verbal descriptions using rigorous instructional techniques (Butcher, 2014; Mayer, 2001), rather than simply flooding the teaching activities with anatomical imagery.

Careful planning of the learning kinaesthetic and palpatory skills, ranging from palpating fellow students to physically examining patients, might need considering, implementing, managing and reviewing annually. The Anatomy Theme Lead could seriously consider setting up an anatomical laboratory with cadaveric specimens, if his/her school does not have one. In the current study, anatomy teachers typically used dissected cadaveric specimens for the students to visualise anatomical structures and develop the tactile side of learning. Running an anatomy laboratory will require familiarity with the Human Tissue Act of 2004, which legally regulates the use of cadaveric specimens for teaching in the UK.

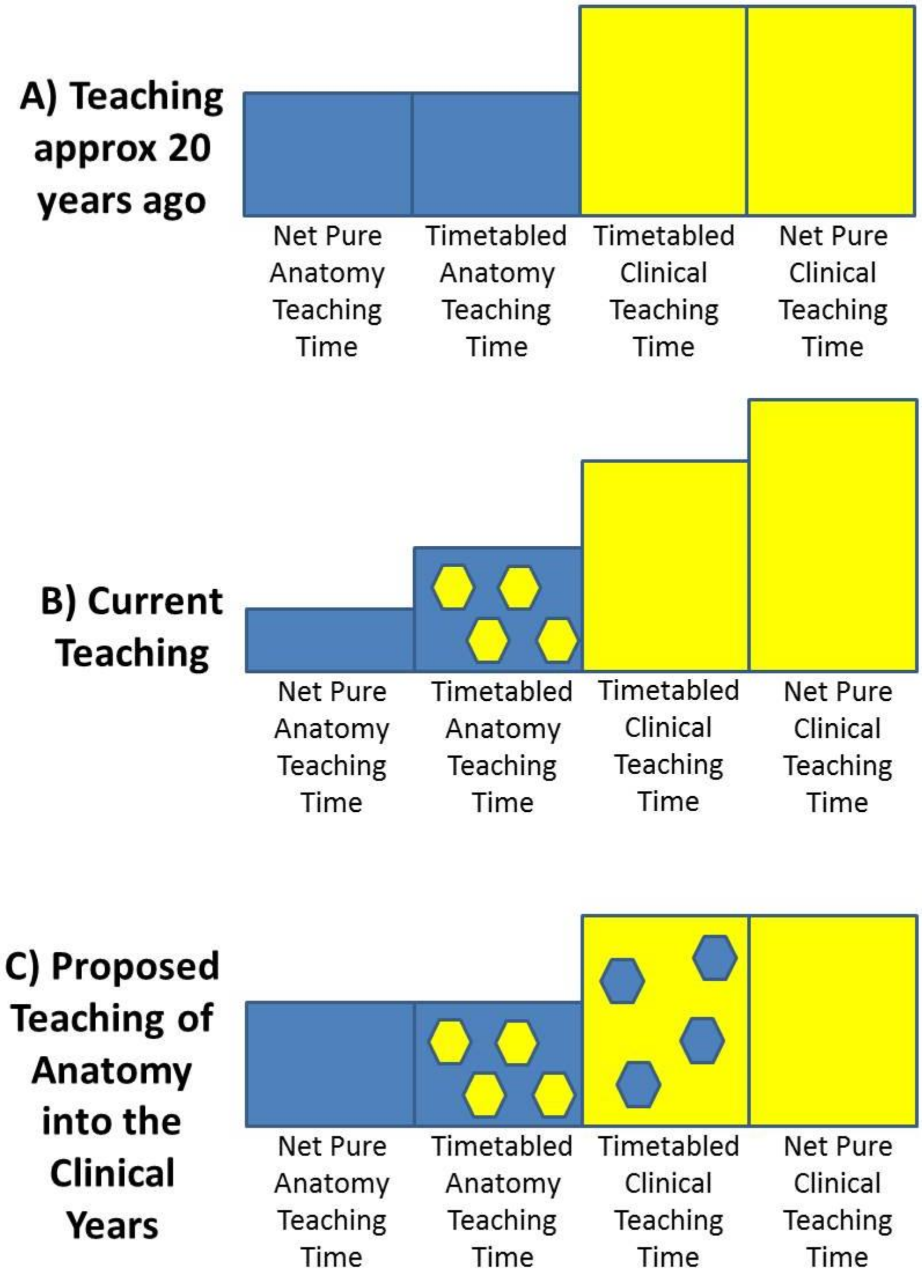
6.3.1.3 Introducing explicit anatomy teaching into the later clinical years

The Anatomy Theme Lead might have to consider how the clinical application could be strategically applied by cultivating the fidelity principle and variability into the fabric of the learning process. The current teaching in the typical anatomy module/s during the 1st year is overloaded and leadership strategies could resolve it by decongesting and potentially spreading some of the explicit learning to the later clinical years.

The reduction in teaching time for anatomy (Bergman et al., 2011; Heylings, 2002; McCrorie, 2000; Paalman, 2000; Pawlina, 2009) might be ameliorated by explicitly introducing anatomy into the clinical teaching sessions of the 2nd and 3rd years of the BSc Physiotherapy programme, especially designed to match the particular clinical placements of the students (Turney, 2007). The integration of anatomy and clinical subjects has been one sided and has meant clinical subjects are introduced into traditional anatomy teaching time, while the reverse has been largely rare (Bergman et al., 2011; McCrorie, 2000). The movement of anatomical teaching into the other remaining clinical undergraduate and postgraduate years is a process called ‘vertical integration’ and has been promoted in anatomy for medical students (Bandaranayake, 2010; Bergman et al., 2011; Dahle, Brynhildsen, Behrbohm Fallsberg, Rundquist, & Hammar, 2002; Leung et al., 2006; Papa & Harasym, 1999; Turney, 2007). Vertical integration helps students to learn what anatomical content is more important (Leung et al., 2006) and is meant to complement horizontal integration where anatomy integrates with other subjects within the same year (Koens et al., 2006). Vertical integration of anatomy for medical students helps the spiral learning (Abu-Hijleh, Chakravarty, & Hamdy, 2004) that relieves the decongestion of the teaching of anatomy from one module or year to the entire undergraduate course (Kabara, 1972).

Vertical integration towards the end of physiotherapy degree programmes was implemented as a short “cap stone” anatomy course (p.156) and its clinical application was recommended (Latman & Lanier, 2001). Vertical integration of anatomy ought to be matched with on-going assessments (T. M. Scott, 1993; Turney, 2007), such as assessing the use of anatomical knowledge during the student clinical placements (Rizzolo et al., 2006). FIGURE 15 on the next page highlights how anatomical teaching was historically initially unintegrated with clinical physiotherapy subjects (as was described under ‘Generational changes in teaching anatomy for physiotherapy’ from page 85, then the present explicit integration of clinical physiotherapy subjects into anatomy and not anatomy into clinical subjects, and lastly the proposed integration of explicit anatomy teaching into the clinical physiotherapy subjects during the clinical years.

Figure 15: Proposed vertical integration - Introducing anatomical teaching into the clinical years



Blue = Anatomy teaching and Yellow = Clinical Physiotherapy teaching

The teaching suggestion could build on the teaching strategy of using clinical cases of patients that was esteemed by the research participants and could benefit from the creation of a list of core clinical cases that teachers of anatomy could focus on during the teaching of anatomy in the clinical years. The following suggestion could help teach anatomy in the clinical placements in a way that uses the more intensive ends of the fidelity and variability principles of the Cognitive Load theory, but in a more organised, systematic and explicit manner. Clinical Student Placement Supervisors might not have time and pedagogical expertise to know how to create the list. The list could help in maintaining similar anatomical standards across the various student placements. There was a lack of systematic and empirical ways of compiling the clinical ‘mini scenario’ cases used for teaching clinical anatomy during the 1st year, which were typically chosen from personal experiences of anatomy teachers, a common practice reported in literature (Banda, 2009). The best 200 cases could be based on the typical workload of a typical entry-level physiotherapist. The ‘thinking aloud’ methodologies of asking clinicians to ‘think aloud’ their clinical reasoning (Boshuizen & Schmidt, 1990; Cutting & Saks, 2012; Patel & Groen, 1986) could help in seeing what anatomical knowledge is necessary in each of the 200 clinical cases, but there is perhaps a more effective but time consuming way.

The most promising and thorough way available of compiling the 200 most relevant physiotherapy cases rich in anatomical knowledge was presented by Banda (Banda, 2009). A provisional list of 500 clinical cases could be compiled from personal experiences and narrowed down to 200 by using the modified Guttman procedure. Banda first compiled a list of ten types of anatomical knowledge (e.g. how body parts function, how body parts are related or the supply of nerves and blood vessels to certain body parts) and ranked them using a scalogram analysis (cumulative scaling) called the modified Guttman procedure (Banda, 2009; Guttman, 1944). The modified Guttman procedure created a maximum composite score of 15 for each clinical case, where clinical cases requiring more detailed anatomical knowledge attracted higher scores (Banda, 2009). Each composite score had three domains of diagnosis, investigations and treatment which each contributed five marks (Banda, 2009). Although the methodology is challenging and complex, and will require defining ten new types of anatomical knowledge relevant for physiotherapy, the results seem to be worthwhile and could be widely used by physiotherapy teachers for teaching anatomy across the world.

An anatomy log book could be created based on the core clinical cases and could help anchor anatomy knowledge around common clinical cases. It can allow for anatomy teachers to remotely monitor the learning of anatomical knowledge in the clinical placements. The Anatomy Log book could in part resemble the ‘Anatomical skill log-book’ suggested by (Abu-Hijleh et al., 1995).

6.3.2 Recommendations for anatomy-teachers-for-physiotherapy

6.3.2.1 Compiling general anatomical principles for physiotherapy

Future research could compile in a more systematic and comprehensive way a set of the two types of general anatomical principles (i.e. general organisation of anatomy and functional use of anatomy) that were described in the Results Chapter in APPENDIX 17 on page 249. A team of anatomy teachers who are physiotherapists could be assembled and three rounds of the Delphi process could be used to refine the anatomical principles consensually, similar to other Delphi-based studies for creating consensual anatomy learning objectives (Edgren, 2006; Rohan, Ahern, & Walsh, 2009; Claire. France. Smith, Finn, Stewart, & Mchanwell, 2016). Once the list of anatomical principles is compiled, care has to be taken to design effective ways of teaching the anatomical principles to physiotherapy students and could include offering varied enough opportunities for them to apply the anatomical principles, in not only controlled educational contexts, but also in real life situations. Future anatomical textbooks and interactive anatomical learning software packages could benefit from these generic anatomical principles. How the general anatomical principles affect metacognition beyond what I described in section 5.2.5 will need to be explored through further research.

6.3.2.2 The need for a unified anatomy textbook for physiotherapy

This current study found that there was no suitable comprehensive anatomy textbook for physiotherapy with appropriate clinical interjections, a similar situation found by others in literature (Mattingly & Barnes, 1994) and anatomical information in the current study was spread across many key anatomical books, as indicated in Section 4.5.1 from page 101 and Section 4.4.1.2.1 from page 88. An anatomy textbook by Moore (K. Moore et al., 2013) was highly recommended for physiotherapy (Mattingly & Barnes, 1994) and also by the anatomy-teachers-for-physiotherapy in the current study. Most anatomy teachers in the current thesis made their own Anatomy Workbooks to guide the learning of their students and is in line with efforts in literature where anatomy-teachers-for-physiotherapy in the USA wrote their own anatomy teaching materials (Mattingly & Barnes, 1994). The physiotherapy students spent a significant amount of time and cognition effort reading and trying to join together information spread across multiple anatomy books that often had unnecessary and redundant information. The current typical recommended sets of anatomy textbooks usually contained an anatomy textbook designed for medical students, a separate book on surface anatomy and a book on functional muscular anatomy.

Anatomy textbooks for medical students contained anatomical descriptions for the whole body and their main clinical focus was how anatomical knowledge was used in medical practice, rather than how physiotherapists used the anatomical knowledge. These medical anatomy textbooks described all the body parts equally and left the physiotherapy students to cherry pick the chapters that were relevant for them, like the upper limb, lower limb, back and the cardiorespiratory anatomy chapters. The surface anatomy textbooks were good at describing the anatomical structures that are found immediately below the skin, but were scanty on the description of anatomical structures located further deeper from the skin. The functional anatomy books were of great use in explaining the structure, function and how to manually test for the presence of muscles, but were weak on non-muscular anatomy. Anatomy Workbooks and other books were additional book sources.

It is likely that the idea of separating sources of anatomy information that the students read leads to the students storing incomplete or partially processed information in their working memory or long-term memory with little or no understanding, while they are searching for the remaining pieces of information in other books. Some anatomy books were described as having exceptional visual anatomical imagery, such as those in Appendix 16 on page 248, and the students would have to memorise the imagery in their visual working memory while they are searching for the matching text in a different book or vice versa. The concept of information spread across many sources, such as the use of many incomplete sources of anatomical knowledge, is called the split-attention principle of the Cognitive-Load theory and unnecessarily increases the extraneous cognitive load (Ayres & Sweller, 2005). The split-attention principle can be split further into the temporal split-attention principle and spatial split-attention principle to denote information split across time and space respectively (Ayres & Sweller, 2005). An anatomy book could be read at different times or two anatomy books could be read at different locations. The decoupling of the imagery from the text is a very inefficient way of using the working memory (Ayres & Sweller, 2005; Kalyuga, Chandler, & Sweller, 2011; Mayer & Moreno, 1998). According to the Cognitive-Load theory, arranging and holding pieces of information in preparation for processing by the working memory is neither learning nor understanding (Kalyuga et al., 2011), although the learning process may develop learning skills in students in how to find and evaluate sources of learning. Evaluating sources of information is a major aim of the Problem-based Learning philosophy for physiotherapy courses (Saarinen-Rahiika & Binkley, 1998) and medical courses (Dolmans et al., 2005; Donner & Bickley, 1993; Pallie & Carr, 1987). Arguably, the searching of anatomical information by students, intentionally scattered around by teachers, into a coherent body of information, over burdens the working memory and is of little benefit to proper learning of anatomical knowledge and changing schemas in their long-term memory (Terrell, 2006). The least extraneous cognition load results if the text is placed closest to the matching diagram of imagery (Kalyuga et al., 2011) and by the removal of a significant amount of redundant information (Kalyuga et al., 2011; Kalyuga & Sweller, 2014), which is either neutral or detrimental to learning (Merriënboer & Ayres, 2005). In summary, if a comprehensive anatomy textbook for physiotherapy could be written with excellent imagery, surface anatomy, functional muscular anatomy, the clinical relevance of physiotherapy and anatomical principles, it could minimise unnecessary information and the need to consolidate anatomical information from numerous sources into one coherent source (Terrell, 2006).

6.3.3 Recommendation for the Chartered Society of Physiotherapy

6.3.3.1 Setting minimum anatomical knowledge standards for students

All the anatomy teachers for physiotherapy felt that the anatomical knowledge that physiotherapy students had to learn was too voluminous, as indicated in the Results Section 4.3.1 from page 84, and sought ways of reducing the volume by focusing on the most essential knowledge, as indicated in Results Section 4.5.2.2.1 from page 104, to make more efficient use of time. The CSP could help drive down the extraneous cognitive loads of the students, anatomy teachers and clinical anatomy teachers by clarifying the core anatomy curriculum (Terrell, 2006). A core anatomy curriculum could give greater guidance to students and teachers on what aspects of anatomy have to be learnt (Older, 2004).

For a number of reasons, the CSP is the institution in the UK in the best position to set guidelines for a core anatomy curriculum for physiotherapy students. The CSP has been an integral part of accrediting training institutions in the UK since the 1920s to present times and has historical documents and members with intimate knowledge of how anatomy was historically taught (Barclay, 1994). The CSP continues to work very closely with the HCPC and clarifies the generic training guidelines set by the HCPC (HCPC-Training-Further-Information, 2015; HCPC-Training-Standards, 2009) to suit the physiotherapy profession. The CSP is better positioned to implement educational changes in physiotherapy schools through its five yearly accreditations (CSP-Accreditation-Supplement, 2016).

The CSP currently has no minimum anatomy standards for students and graduates of the BSc Physiotherapy which could help safeguard against dropping below acceptable competency levels. The General Medical Council previously did not give anatomical guidance for medical students either (Turney, 2007), but later did (Rubin, 2009). Physiotherapy schools are left to set their own minimum standards to achieve CSP accreditation (CSP-Learning-Principles-for-Accreditation, 2011). Insufficient anatomical knowledge compromises the safety of patients, being able to effectively communicate with other health practitioners (Turney, 2007) and poorly prepares medical graduates for postgraduate training in medical related specialties (Collins & Given, 1994; Cottam, 1999). There is a minimum threshold of anatomical knowledge where medical litigation due to deficits in anatomical knowledge are more prone to happen (Ellis, 2002) and that minimum threshold was feared to have been breached for some medical students (Turney, 2007). Consequently, anatomy learning outcomes were later set for medical programmes in the UK by committees of anatomy experts as a way of setting minimum standards (Association-of-British-Neurologists, 1995; McHanwell et al., 2007; Rubin, 2009; Claire. France. Smith, Finn, Stewart, Atkinson, et al., 2016) and endorsed by the General Medical Council of the UK (Rubin, 2009), but not for physiotherapy (Latman & Lanier, 2001). Similarly, the setting of minimum anatomy standards for the physiotherapy profession could be addressed by compiling anatomy learning outcomes for physiotherapy through a Delphi-based methodology (Edgren, 2006; McHanwell et al., 2007; Rohan et al., 2009; Claire. France. Smith, Finn, Stewart, & Mchanwell, 2016).

It could be strategic for the proposed core curriculum to give academic flexibility to the physiotherapy schools and not have anatomy learning outcomes that are too prescriptive (Abu-Hijleh, 2010) because facts and knowledge related to anatomy and the evolving practice of physiotherapy will continue to change (T. M. Scott, 2000). Some of the objectives ought to be dynamic and relevant for changing demands found in the clinical hospital setting (T. M. Scott, 2000). Perhaps 30 of the 200 clinical cases in Section 6.3.1.3 from page 159 could teach the anatomy that underpins new emerging conditions or situations from the last five or ten years, like the Zika virus presenting in newly born babies with smaller brains and heads. Anatomical knowledge of the embryological development of the brain in a foetus and how the brain is responsible for controlling sitting, standing and walking would be helpful. Physiotherapists could use postural training and other exercises to help the child to reach the delayed developmental milestones.

Care has to be taken to balance out the anatomical knowledge and skills for the different specialties because each specialty tends to give more curricula attention for their own specialty (Bithell, 2007). Physiotherapy specialists tend to advocate for more curricular space for anatomical knowledge for their own specialty, in what Claire on page 111 called their 'pet bits'. The specialty bias then causes the clinical specialists to more likely teach anatomical knowledge and skills beyond the scope of undergraduates (Bandaranayake, 2010; Bergman et al., 2011). It should be borne in mind that the undergraduate anatomical knowledge and skills ought to be pitched at the level of entry-level physiotherapists (band 5 of the NHS salary grading system) and will help reduce the inclusion of anatomical knowledge beyond their scope.

6.3.3.2 The need for setting up a Society of Anatomy Teachers for Physiotherapy

The way the anatomy teachers described in the Results Chapter how they taught anatomy did not typically show evidence of being based on pedagogical ideas from academic papers or conferences. Most of the mini-case profiles of the participants in Section 4.2.1.1 from page 76 did not exhibit such scholarly journal activities. The literature review in Section 2.3.1 from page 11 supports the view that British anatomy teachers for physiotherapy have a relatively weak track record in publishing on anatomical pedagogy, especially qualitative methodologies to develop pedagogical theoretical frameworks. Consequently, the overall teaching and learning of anatomy for undergraduate physiotherapy students in the UK remains uncharacterised (as indicated in Section 2.3.1 from page 11.

Academic scholarship among anatomy teachers for physiotherapy could be stirred into action by promoting the setting up an academic community for British anatomy teachers for physiotherapy that brings together three fields of specialisation (anatomy, physiotherapy and education), which is presently lacking in the UK. Currently, these three fields are being promoted by three separate institutional approaches: the Higher Education Academy, two British anatomical societies and the CSP. The first two institutional approaches will be argued as inappropriate for promoting joint academic scholarship on anatomy, physiotherapy and education and the CSP will be put forward as the most promising of the three institutions.

There was a high regard for the Fellowship credentials of the Higher Education Academy by the participants. All the participating anatomy teachers were Fellows or Senior Fellows of the Higher Education Academy except the most junior anatomy teacher in the study, Marie. The driving philosophy of achieving fellowship with the Higher Education Academy is based on reflective practitioners of education (Brockbank & McGill, 2007) and is not directly related to the educators being able to publish on teaching scholarship in journals. Anatomy teachers for physiotherapy may be awarded fellowship on other areas of their teaching practice not related to teaching anatomy and consequently may not be familiar with established anatomy pedagogical ideas matching their preferred pedagogical strategies.

While the Higher Education Academy credentials may indicate interest by the anatomy teachers on teaching and learning practice and scholarship, the credentials may be a mandatory requirement set by the universities for completing probation or promotion, as in my two previous universities. My current university has set a target that 75% of its teachers ought to have attained fellowship with the Higher Education Academy by 2018 in preparation for the new ‘Teaching Excellence Framework’ starting in 2017. High proportions of teaching staff with Fellowship from the Higher Education Academy in a university will reflect positively on how much the university values teaching and boost the 'Teaching Excellence Framework' rating of a university on 'Teaching Quality' (DfE, 2016). The Higher Education Academy has been moving towards discipline specific support within the Health and Social Care sector since 2015-16 and runs anatomy specific academic conferences co-ordinated by an Anatomy National Teaching Fellow (Higher-Education-Academy, 2015). However, the Higher Education Academy approach lacks focus on anatomy for physiotherapy though.

There are two anatomical societies within the UK: the Anatomical Society and the British Association of Clinical Anatomists. The Anatomical Society is an academic society for anatomy researchers, teachers and clinicians and runs a two year part-time Training Programme in Anatomy for anatomy teaching entrants (Anatomical-Society, 2016), while the British Association of Clinical Anatomists largely has clinicians with an interest in anatomy (British-Association-of-Clinical-Anatomists, 2014). Both societies host annual or biannual conferences and are affiliated to respective anatomical journals, but do not provide a meaningful platform to coalesce British scholarship on teaching anatomy for physiotherapy.

The CSP, with over 56 000 chartered physiotherapists, physiotherapy students and support workers, has 35 in-house professional networks representing various areas of physiotherapy specialisations (CSP-Networks, 2016). The CSP website contains an InteractiveCSP website platform that allows physiotherapists to share information and ideas (CSP-InteractiveCSP, 2016). The InteractiveCSP has a number of education related groups like the 'CSP Education' forum on it, which meets twice a year and publishes a six monthly education newsletter called the 'Ed Bulletin (CSP-Education-Forum, 2016). A professional network potentially called 'Society of Anatomy Teachers for Physiotherapy' could be set up as a subgroup of the 'CSP Education' forum to give it credibility and influence within the physiotherapy community in the UK. The society could preferably be at arm's length from the CSP executive and the CSP department that accredits physiotherapy schools. The society could champion the role of anatomical education for physiotherapy by running academic meetings, publishing periodic newsletters/journals and influencing the CSP executive and the accreditation department and the HCPC.

The society could promote a better grasp of how anatomy in the UK is taught and learnt and could include reviewing historical events currently influencing the teaching of anatomy for physiotherapy, how anatomy for physiotherapy is currently taught and learnt and how to best educationally prepare for future changes within the physiotherapy world that would require modifying how anatomy is taught. Anatomical knowledge tends to be forgotten with time (as indicated in Section **4.3.4** from page **86**) and the network could support qualified practising physiotherapists in refreshing forgotten anatomical knowledge and skills and support the professional development of both the younger and established anatomy teachers for physiotherapy.

6.3.4 Other suggestions for future research

There was a lack of specialist anatomical training and experiences in all but one of the anatomy teachers in the current study (Nathan was an exception, please refer to page 78), when they took up their first anatomy teaching job.

The typical anatomy teacher in the current study had their postgraduate anatomical training on-the-job, as exemplified by the quotation below:

> "I don't have any formal anatomical training to teach anatomy, if that makes sense. I learnt my own anatomy as a student, anatomy updating as a clinician and then preparation as a lecturer … The more you teach it, the better you become at it." (Claire)

The qualifications of anatomy teachers ought to improve the quality based on the assumption that the quality of learning is influenced by who is teaching, despite the lack of literature to support or contradict this link (Bergman et al., 2011), although the opposite may apply. Similar concerns were raised in the USA on whether anatomy teachers for physiotherapy had the appropriate qualifications, experiences and clinical expertise to teach anatomy for physiotherapy (Mattingly & Barnes, 1994). Future research is warranted to examine if anatomical training and qualification of anatomy teachers for physiotherapy in the UK has a positive impact on the quality of teaching anatomy to physiotherapy students.

6.4 Limitations of the study

The limitations of the study can be broadly grouped into methodological limitations and limitations of the Cognitive-Load theory. There were clinical physiotherapy teachers who taught anatomy in the 2nd and 3rd years, besides the anatomy teachers, such as the Clinical Musculoskeletal, Clinical Respiratory and Clinical Neurology physiotherapy specialist lecturers and the Clinical Students Placement Supervisors, and their role only became apparent during the analysis of the grounded theory methodology. The clinical physiotherapy teachers taught anatomy as a minor part of their teaching, while the anatomy teachers taught anatomy as a major part of their teaching. With hindsight, could the current study have included the clinical anatomy teachers as part of its participants? No, the clinical physiotherapy teachers should not have been included because they only played a peripheral teaching role when compared to the 1st year anatomy-teachers-for-physiotherapy. The current study is a ground breaking study into the teaching of anatomy for physiotherapy within the UK. The richest overview description of teaching anatomy and most dominant teaching strategies can be best obtained from those who made the largest contribution to teaching anatomy and who are most likely to think of anatomical pedagogy.

Among the methodological limitations, was whether the inclusion of students as participants could have revealed how the five dominant pedagogical concepts would have impacted on their learning? Choosing students could have violated the basis for choosing the epistemology of radical constructivism for supporting the current research objectives and would have made the current study too large and beyond the scope of an EdD thesis. The current study had to analyse eight transcripts with a total of 72 292 words. The opinions of students are more polarised than opinions of anatomy teachers (Bergman et al., 2011) and are harder to be 'taken-as-shared' (Cobb et al., 1992) with the opinions of anatomy teachers. Future studies could explore the dominant pedagogical concepts from the views of the physiotherapy students.

The Cognitive-Load theory is based on the cognitive burden placed on the cognitive apparatus of the students (Chandler & Sweller, 1991; Mayer, 2014c; Merriënboer & Kester, 2014; Sweller, 1994). The teaching strategies of the teachers in the current study were explained based on the assumptions that the cognitive loads on the students could be worked out from the learning and task performances of the students described by the anatomy teachers.

The Cognitive-Load theory has its own limitations. There were some comments from the anatomy teachers that some of the physiotherapy students were not motivated to learn anatomy (please see in Section 4.4.3.2 on page 97) and such low levels of motivations are well known to handicap the germane load (Schnotz & Kürschner, 2007). Unfortunately motivation is ignored by the Cognitive-Load theory (Bannert, 2006; P. A. Kirschner et al., 2011). The gender theme did not emerge from the grounded analysis. It was not clear if gender of the physiotherapy students affected any one of the five major pedagogical concepts, despite all the universities assessed having at least 60% females and was as high as 90% in one university, please refer to GRAPH 5 on page 81.

One of the objectives was to describe pedagogical concepts that helped their students to learn anatomy in the long-term, for example five years after graduation. In practice, the anatomy teachers could only 'see' the learning effects largely in the first undergraduate year in all the physiotherapy schools except Kelly's exemplary school. The results of the current study were more heavily weighted towards the 1st year of the physiotherapy degree programmes because it is where the 1st year anatomy-teachers-for-physiotherapy had first-hand experiences, while the anatomy teaching for remaining undergraduate years were based on second-hand experiences.

The current study did not explore how the teaching and learning was carried out for students on the alternative physiotherapy courses that deviate from the three year BSc Physiotherapy programme dominated by high school leavers. There are alternative qualifications routes for obtaining registration as a physiotherapist in the UK, largely used by mature students with first degrees (Bithell, 2007). Potential physiotherapists can either obtain a pre-registration Post-graduate Diploma (from nine universities), accelerated two-year pre-registration MSc in Physiotherapy degree (from 23 universities) or a Doctorate in Physiotherapy (from a single university) (Bithell, 2007; CSP-History, 2015; HCPC-Register, 2015; Robert-Gordon-University, 2016a).

6.5 Personal Reflections on the EdD study

6.5.1 Reflection on my pedagogical development for teaching anatomy

I had exposure to a plethora of pedagogical theories and principles before the start of the EdD thesis, but I was not sure which ones were at play in teaching anatomy for physiotherapy in the UK. The five pedagogical principles from the current study provides me with a foundation to help me start explaining the teaching and learning of anatomy for physiotherapy in the UK and finding ways of refining and improving them.

I put my preferred pedagogical concepts for teaching anatomy upfront in Section 3.5.4.2 from page 61 before my research interviews to act as a reference against possible unconscious importation of ideas into the five major pedagogical concepts described in Section 5.2 from page 119. Only three of my pedagogical preferences were broadly in-line with three of the dominant pedagogical concepts that arose from the study, while my preferences on reflecting anatomical knowledge and having explicit learning outcomes did not emerge as dominant themes. My three preferences generally lacked clarity on the mechanisms, factors and dynamics underpinning each of the dominant pedagogical concepts. My broad three preferences became more grounded in the experiences of other anatomy teachers and in other university settings in the UK as a result of this thesis.

My second 'Manageable student workload' concept conveyed my fears that the anatomical content the students were expected to learn was too voluminous and needed narrowing down, but I was not sure how. The 5th pedagogical concept of the thesis of 'using anatomical principles for metacognition' provides a convincing teaching strategy of how the anatomy volume the students are expected to learn could be reduced. The reduction is through the use of anatomical principles that could be applied to many more situations in the body. I have started thinking aloud during my tutorial teaching sessions to show the students how general anatomical principles can provide metacognition information strategies, in line with Cutting & Saks (Cutting & Saks, 2012).

The amount of clinical anatomy was another similarity between my pre-thesis opinion and third major pedagogical concepts from the thesis. My original thoughts expected anatomy teachers to explain the clinical relevance of anatomy, but I was surprised to see how anatomy teachers taught the physiotherapy students practical clinical anatomical knowledge, rather than just knowledge. The clinical complement of anatomy was possible because all the anatomy teachers were registered physiotherapists, who were more comfortable at teaching the more clinical complements of anatomy. All my previous experiences were of seeing non-physiotherapist anatomy teachers teaching anatomy for physiotherapy to physiotherapy students (at the University of Zimbabwe, University of Cape Town and the University of East Anglia). I have become more convinced in having qualified physiotherapists teaching anatomy.

My other pre-thesis opinion was that anatomical content should be more spread-out throughout the three years of physiotherapy undergraduate training. The spiral curriculum concurred with more spreading out of anatomical teaching, but was more sophisticated. The anatomy teaching started with the more simple anatomical concepts moving on to more complex concepts, while the teaching support was initially more intensive and tapered towards the end to minimal support. While my idea of spreading out the voluminous anatomical content and teaching each content section once, the thesis differed from my approach by reinforcement teaching of similar content repeatedly over a period.

Prior to starting the research interviews, it was my understanding (based on my teaching experiences) that teaching anatomy well for future careers was about excellent teaching by the anatomy teachers themselves. This view explains why the 5th objective of how to measure successful learning of anatomy five years after graduating was based on what the anatomy teachers themselves taught during the pre-clinical years, and I subconsciously thought that anatomical knowledge could be stored in the permastore during the 1st year. I am of the persuasion now that successful long-term learning of anatomy depends on the reinforcements of learning by the anatomy teachers during the clinical years and beyond, rather than by placing anatomical knowledge in the permastore of students during the 1st year. Currently 100% of the undergraduate teaching of anatomy in my Anatomy Department is conducted during the pre-clinical years and I will aim to spread it more across all the undergraduate years.

My prior expectations of how anatomical training and education contributed to the 18 sub-domains of the CSP differed from how the five dominant pedagogical concepts from the thesis contributed, and both have been placed alongside the 18 sub-domains of the CSP in APPENDIX 18 from page 250. The CSP has developed a framework of domains and sub-domains and their descriptors for the various physiotherapy expertise levels: support, advanced support, entry-level graduate, experienced graduate and advanced physiotherapy experts (CSP-Accreditation-Supplement-Framework, 2016; CSP-Physiotherapy-Framework, 2011; CSP-Physiotherapy-Framework-Condensed-Version, 2013). My expectations were that anatomical education and training only affects five of the 18 sub-domains of knowledge and understanding, physiotherapy practice (like palpation), communicating (using correct anatomical terminology), promoting integration and teamwork (learning anatomy in teams) and lifelong learning. The three sub-domains targeted by my expectations of anatomical education and training matched the sub-domains targeted by the four major pedagogical concepts from this study, but contributed to the same sub-domains differently. The mapping of how anatomical training and education feeds into the 18 sub-domains of the CSP could form part of the application documentation for physiotherapy schools wanting to gain CSP accreditation to run BSc Physiotherapy degree programmes.

6.5.2 Reflection on my personal professional development

The EdD programme and thesis has transformed me in many ways. Over the course of this thesis I have read extensively over 800 articles, documents and books. In preparing for the literature review I have read over 300 papers on teaching anatomy to medical and physiotherapy students and read on the physiotherapy profession, how anatomy for physiotherapy is being taught, the assessment of anatomy and the regulation of physiotherapy training and education in the UK. It was in the designing of the methodology and research that I was first introduced to the concept of epistemology and the philosophical corner of radical constructivism eventually became the epistemological viewpoint for this thesis after considering many other epistemologies. The desire to find or develop a theoretical framework to analyse the Findings Chapter prompted me to critically review Bloom's Taxonomy (L. W. Anderson et al., 2000), Kolb's cycle for learning (Hickcox, 1990), learning styles (Sternberg & Zhang, 2001) and andragogy (Knowles, Holton, & Swanson, 2015; Knowles, 1990; Lawson, 1975), but finally settled on Cognitive-Load theory (Plass et al., 2010a; Sweller et al., 2011). The literature on multimedia learning (Mayer, 2014c) held better promise for explaining the teaching and learning of anatomy for physiotherapy because of the strong visual element. Literature along the multimedia path exposed me to the Dual-coding theory of Paivio (Paivio, 1979, 1990, 2013; Sadoski & Paivio, 2013), Baddeley's theory on the working short-term memory (Baddeley & Hitch, 1974; Baddeley, 2000, 2003) and the 4CID theory designed primarily for medical education (Merriënboer et al., 1992; Merriënboer & Kirschner, 2013; Merriënboer, 1997).

I have had many major life events since starting my EdD degree programme in 2012. I married in 2013, moved to a different city in 2014 for a new anatomy teaching job in Birmingham. I changed my house in 2014 and again in 2015 and this entailed packing everything in the house and unpacking it again in the next house. Some of these challenges account (Gill et al., 2009) for why only 34% of part-time doctoral students in the UK complete their degree within 7 years (HEFCE, 2007), despite the maximum limit for the degree programme being 7 years (Burgess et al., 2006).

I am from a very strong scientific and quantitative background. The EdD degree programme has developed my depth and competency in humanities and qualitative research. One of the strengths of an EdD programme is that there are more opportunities to pursue other research areas (Gill et al., 2009). I was delighted when two of my earlier EdD modules were published in journals. The first paper was about leading and managing an Anatomy Department in an African country in the midst of several confusing and ambiguous goals and pressures (Gangata, 2016) in Appendix 32 from page 375. The second paper was on education policy of how cadavers can be sourced ethically around the world through a proposed classification system (Gangata, 2015) in Appendix 33 from page 384. I am hoping to publish a journal manuscript from this thesis on teaching anatomy for physiotherapy and another on proposing a new version of the existing Cognitive-Load theory in competitive and peer-reviewed international journals.

There is a shortage of health professionals with doctoral level of educational expertise (Gill et al., 2009). The EdD degree will help improve my teaching expertise and credentials within the health sector. I discovered my passion for teaching when I worked as a private mathematics tutor to augment my university stipend in 1998. I was the first physiotherapist to specialise in anatomy in my country of birth Zimbabwe, as described in my autobiography book (Gangata, 2012). I am currently on a promising teaching path and was shortlisted as an Outstanding Teacher of the Year in my first year at the University of Birmingham in 2015 and nominated in 2017 (the letters are in Appendix 20 and Appendix 21 on page 255 and 256 respectively), as evidence of my teaching dedication

The recommendations of this EdD thesis are for anatomy teachers, BSc Physiotherapy Programme Leads and the CSP, and requires leadership and expertise from anatomy, physiotherapy and educational pedagogy fields. My intimate knowledge of the recommendations of this doctoral thesis and my experiences and qualifications spanning education, anatomy and physiotherapy potentially places me in an influential position to initiate and be part of these recommendations. I have been invited to present through both oral and poster presentations the abstract of this EdD thesis at the upcoming prestigious annual conference of the CSP called 'Physiotherapy UK 2017' Conference in Birmingham in November 2017 and a copy of the offer and confirmatory letters are in Appendix 22 and Appendix 23 on page 257 and page 259 respectively. It is an opportunity to share the research findings and recommendations with the wider physiotherapy community within the UK and to create networking contacts.

I have begun preparations for my next research phase after my EdD thesis. I have secured research colleagues to partner with and submitted three educational studies for ethical approval in September 2017 entitled:

i. A composite index system for determining the most anatomy rich physiotherapy clinical cases for teaching anatomy during undergraduate musculoskeletal student placements in the UK.
ii. A core syllabus in anatomy for physiotherapy students in the United Kingdom.
iii. Educational Research: What role does knowledge of human anatomy play in practising pharmacy?

The first two studies are in response to the recommendations in Section 6.3.1.3 from page 159 and Section 6.3.3.1 from page 165 respectively. The first study hopes to promote the fidelity principle of the Cognitive Load theory by proposing a very systematic way of compiling anatomy rich clinical physiotherapy cases recommended in Section 6.3.1.3 from page 159. The second study aims to address the recommendation of reducing the extraneous load of the Cognitive Load theory by creating a core anatomy curriculum for physiotherapy students. The third study is not a follow-on recommendation of the current thesis, but uses the same Grounded Theory methodology of the current thesis.

Last year I reviewed the requirements for Senior Fellowship with the Higher Education Academy. I felt that with the significant teaching leadership roles I have or had, my progress on the EdD degree and the potential of being involved in the recommendations of the thesis, I was in a strong position to apply for the Senior Fellowship. I submitted a well reflected application for Senior Fellowship in May 2017 and I was granted Senior Fellowship in June 2017 and a copy of the letter is in APPENDIX 24 on page 260. The assessor of my application noted that my progress on the "EdD, coupled with published pedagogical papers, is perhaps more than many applicants can claim". I hope to target being a National Teaching Fellowship with the Higher Education Academy in the next few years. In conclusion, the impact of the EdD degree programme on my teaching practice, educational research and career has been profound.

6.6 Conclusion

In conclusion, the teaching of anatomy for physiotherapy in the UK has been neglected and this thesis has partially filled the void by characterising the five dominant pedagogical concepts used by anatomy-teachers-for-physiotherapy for largely teaching musculoskeletal anatomy. The anatomy teachers used a set of five pedagogical concepts: a spirally arranged curriculum, widespread use of visual anatomical imagery, endorsed kinaesthetic anatomical skills, clinically applied anatomical knowledge and skills to physiotherapy situations and used anatomical principles for metacognitive strategies. These five pedagogical concepts have credibility and have been endorsed in medical education literature (Cutting & Saks, 2012; Paalman, 2000).

The results revealed that anatomy was typically taught across the three undergraduate years of the BSc in Physiotherapy degree. Anatomy modules were usually taught by anatomy teachers during the 1st year, mainly through Tutorial Anatomy Practicals. The tutorials used highly visual anatomical learning aids, practiced kinaesthetic and haptic intensive anatomical skills and anatomy was aimed at preparing the physiotherapy students to use anatomical knowledge and skills to treat patients. There was a strong focus during the Tutorial Anatomy Practicals in teaching anatomy principles that could be applied in many more anatomical situations as a way of coping with teaching voluminous anatomical content within the insufficient allocated teaching time. The learning of voluminous anatomical content was associated with forgetting of previously learnt anatomical knowledge.

The teaching of anatomy in the 2nd and 3rd years (clinical years) was different from the 1st year teaching. Anatomy during the clinical years was taught by Specialist Clinical Physiotherapy Lecturers (campus-based) and Student Placement Supervisors (hospital-based), rather than by anatomy teachers. Anatomy teaching in the clinical years was typically implicit, informal and poorly structured and had no dedicated anatomical assessments.

The dominant concepts have been argued from the 4CID and the Cognitive-Load theoretical frameworks. Deviations from the Cognitive-Load theory have been used for proposing a modified Cognitive-Load theory for novice learners learning voluminous information that accounts for forgetting, a long-term memory with a limited capacity and the use of haptic learning in practical-based fields.

Recommendations have been made and are centred on having Anatomy Theme Leads having responsibility for planning, implementing and managing the dominant pedagogical concepts in all the anatomy teaching across the undergraduate and postgraduate physiotherapy degree programmes. The CSP could reduce the neglect of anatomical teaching through its five yearly accreditations of BSc Physiotherapy programme standards by setting minimum knowledge and skills standards and minimum qualifications for anatomy-teachers-for-physiotherapy and Anatomy Theme Leads. Anatomy-teachers-for-physiotherapy could improve anatomy teaching by writing a comprehensive anatomy textbook for the physiotherapy profession, systematically compiling key anatomical principles to teach and organising themselves into a society to promote their interests. The EdD thesis has the potential to influence anatomical teaching for physiotherapy in the UK. I am hoping to submit two manuscripts to journals: one on the five dominant pedagogical concepts and the other on proposing a new version of the Cognitive-Load theory.

7 References

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Appendix 1: Forty six fields of specialism of physiotherapy in the UK

The appendix illustrates 46 of the physiotherapy specialties found in the UK and briefly describes some of the conditions that are treated on patients within each specialty.

Clinical fields of application or areas of specialisation	**Description** The provision of appropriate physiotherapy services to patients with … (* = exceptions to this leading phrase)	**Examples of conditions treated** Patients with…	**British Professional Organisation** promoting the specialisation (CSP-Professional-Networks, 2013)	**Reference**
Academic physiotherapy	*(Teaching physiotherapy students and conducting research relevant to physiotherapy)	lower back pain being research participants to find best treatment regimes	Physiotherapy Research Society http://prs.csp.org.uk/	(Hurst, 2010; Stevenson, Chadwick, & Hunter, 2004)
Acupuncture Physiotherapy	Pain	Back pain or osteoarthritis	Acupuncture Association of Chartered Physiotherapists http://www.aacp.org.uk/	(Richardson & Vincent, 1986)
Amputation Physiotherapy	Amputations	Below knee amputation	British Association of Chartered Physiotherapists in Amputee Rehabilitation http://bacpar.csp.org.uk/	
Bobath Physiotherapy	Children with brain conditions affecting developmental milestones	Children with meningitis whocannot crawl at one year	British Association of Bobath Trained Therapists http://www.bobath.org.uk/clinical-information/british-association-of-bobath-trained-therapists/	
Burns Physiotherapy	Serious skin burns	Third degree burns on the face	British Burn Association http://www.britishburnassociation.org/physiotherapy	
Cardiac Physiotherapy	Heart conditions	Heart attack	Association of Chartered Physiotherapists in Cardiac Rehabilitation http://acpicr.com/	
Chest Physiotherapy	Respiratory conditions	Cystic fibrosis	Association for Chartered Physiotherapists in Respiratory Care http://www.acprc.org.uk/	(J. H. Cole, 1983)
Community physiotherapy	Difficulty in travelling for physiotherapy services	Strokes or patients with poor eyesight	ACPC Association of Chartered Physiotherapists in the Community	(Partridge, 1987)
Continence Physiotherapy	Being able to control urination and defaecation	Mothers after child birth	Chartered Physiotherapists Promoting Continence	
Craniosacral Therapy	An alternative therapy involving light touches to heal various conditions of the spine and restore vitality	Patients with back problems after trauma	Craniosacral Therapy Association of Chartered Physiotherapists http://www.energymedphysio.org.uk/index.asp?pageid=415692	
Cystic Fibrosis Physiotherapy	Treating patients with cystic fibrosis	With excess mucus in their airways	Association of Chartered Physiotherapists in Cystic Fibrosis http://www.csp.org.uk/professional-networks/acpcf	
Developmental Physiotherapy	*(Concerned with promoting physiotherapy		Chartered Physiotherapists in International Health and Development	

	worldwide)		http://adapt.csp.org.uk/about-us	
Electrophysiology Physiotherapy	Problems with peripheral (body) nerves	Injured nerves	Electro-Physical Agents and Diagnostic Ultrasound	
Extended Scope Physiotherapy	*(Physiotherapy concerned with going beyond the common scope of practice of physiotherapy)	Ordering blood tests in order to make a diagnosis	Extended Scope Practitioners http://www.esp-physio.co.uk/	
Emergency Physiotherapy	Acute musculoskeletal conditions	Pain, muscle tension and dislocations		(Anaf & Sheppard, 2007, 2010; Kilner & Sheppard, 2010)
Energy Medicine	The underlying physics of bio-energetic therapies	The physics underlying ultrasonography treatment	Association of Chartered Physiotherapists in Energy Medicine http://www.energymedphysio.org.uk/acpemoverviewofenergymedicine.asp	
Geriatric (Elderly) Physiotherapy	*(The provision of appropriate physiotherapy services to who are elderly persons and needing physiotherapy services)	Joint degeneration conditions like osteoarthritis	Chartered Physiotherapists working with older people http://agile.csp.org.uk/	(Squires & Hastings, 1997)
Hand-therapy Physiotherapy	Hand and wrist conditions	Hand bone fracture	British Association of Hand Therapists http://www.hand-therapy.co.uk/	
Hippotherapy	*(Physiotherapy concerned with the use of horse riding to treat conditions)	Children with poor trunk balance control	Association of Chartered Physiotherapists in therapeutic riding http://acptr.csp.org.uk/	
Hydrotherapy	*(Physiotherapy concerned with the use of water to treat conditions)	Cannot fully carry their weight due to knee osteoarthritis	Aquatic Therapy Association of Chartered Physiotherapists http://atacp.csp.org.uk/	
Injection Therapy	*(Physiotherapy concerned with treatment using injections)	Painful hip joint	Association of Chartered Physiotherapists in Orthopaedic Medicine and Injection Therapy http://www.acpomit.co.uk/	
Intensive care Physiotherapy	Life critical threatening conditions requiring organ support and frequent monitoring	Patients in a coma	Critical Care Physiotherapy http://www.csp.org.uk/professional-union/practice/evidence-base/physiotherapy-works/critical-care	
International Health and Education	International, global and developmental health issues		Chartered Physiotherapists in International Health and Education	
Leaders and Managers of Physiotherapy Services	*(Physiotherapists who are in leadership and management positions)		Leaders and Managers of Physiotherapy Services http://lamps.csp.org.uk/about-us	
Learning Disability Physiotherapy	People with learning disabilities	Patient with autism requiring physiotherapy	Association Of Chartered Physiotherapists For People With Learning Disabilities http://acppld.csp.org.uk/	
Legal Physiotherapy	*(Providing legal services for physiotherapy related activities)	Legal advice for physiotherapy malpractice	Medico Legal Association of Chartered Physiotherapists http://www.mlacp.org.uk/	

Massage Physiotherapy	Massage	Tense back muscles	Chartered Physiotherapists Interested in Massage and Soft Tissue Therapies http://www.csp.org.uk/professional-networks/cpmastt	
Manipulative Physiotherapy	Joint conditions	Immobile and dislocated joints	Musculoskeletal Association of Chartered Physiotherapists https://macpweb.org/home/	
McKenzie Physiotherapy	Musculoskeletal conditions that could benefit from self-treatment using posture	Recent neck pain	McKenzie Institute Mechanical Diagnosis & Therapy Practitioners http://www.mckenzieinstitute.org/united-kingdom	
Mental health Physiotherapy	Mental conditions	Schizophrenia and having a fracture	Chartered Physiotherapists in Mental Health http://www.csp.org.uk/tagged/chartered-physiotherapists-mental-healthcare-cpmh	
Musculoskeletal (orthopaedic) Physiotherapy	Conditions involving muscles, nerves, bones or joints	Fractures and nerve paralysis	Association of Orthopaedic Chartered Physiotherapists and the Musculoskeletal Association of Chartered Physiotherapists https://macpweb.org/home/	(J. H. Cole, 1983)
Neurological Physiotherapy	Conditions involving the brain and spinal cord	Stoke and spinal cord damage (paraplegia)	Association of Chartered Physiotherapists in Neurology http://www.acpin.net/	(J. H. Cole, 1983)
Occupational health Physiotherapy	*(Musculoskeletal conditions caused by unsuitable workplaces)	Addressing pain due to faulty chair design	Association of Chartered Physiotherapists in Occupational Health and Ergonomics http://www.acpohe.org.uk/	
Orthopaedic Medicine and Injection Therapy	Using medical knowledge in musculoskeletal conditions	Injecting joints of sports persons	Association of Chartered Physiotherapists in Orthopaedic Medicine and Injection Therapy https://www.acpomit.co.uk/	
Outpatient Physiotherapy	Conditions that can treated with day visits to the hospital	Ankle sprain		(Dawson & Ghazi, 2004)
Pain Physiotherapy	Pain	Hip joint with painful osteoarthritis	Physiotherapy Pain Association http://ppa.csp.org.uk/	
Palliative Physiotherapy	Cancer or terminal conditions	Spinal cord cancer	Association of Chartered Physiotherapists in Oncology and Palliative Care http://acpopc.csp.org.uk/	
Paediatric Physiotherapy	*(The provision of appropriate physiotherapy services to patients who are babies, infants and children)	Congenital heart conditions, e.g. babies with a hole in the heart (patent foramen ovale)	The Association of Paediatric Chartered Physiotherapists http://apcp.csp.org.uk/	(J. H. Cole, 1983)
Private Physiotherapy	*(Patients who can afford to pay privately for physiotherapy services)	Any condition requiring physiotherapy	Association Of Chartered Physiotherapists in Independent Healthcare http://acpihc.csp.org.uk/	
Reflex Physiotherapy	Requiring relaxation	Tight muscles	Association of Chartered Physiotherapists in Reflex Therapy http://acpirt.csp.org.uk/	

Sports Physiotherapy	Active in sports and aims to maximise their performance and reduce the time to full fitness	Torn knee ligaments	Association of Chartered Physiotherapists in Sports and Exercise Medicine http://www.physiosinsport.org/	
Therapeutic Riding	Using horse ride as part of treatment	A child with balance problems	Association of Chartered Physiotherapists in Therapeutic Riding and Hippotherapy http://cptrh.csp.org.uk/	
Vestibular Physiotherapists	Balance problems	Inner ear disorders	Association of Chartered Physiotherapists Interested in Vestibular Rehabilitation http://www.csp.org.uk/professional-networks/acpivr	
Veterinary Physiotherapy	*(The provision of appropriate physiotherapy services to animals that have conditions that can benefit from physiotherapy services)	A racing horse with a fractured foot	Association of Chartered Physiotherapists in Animal Therapy http://www.acpat.org/	
Women's health Physiotherapy	*(The provision of appropriate physiotherapy services to women of the child bearing age)	Incontinence due weak pelvic muscles	Pelvic, Obstetric and Gynaecological Physiotherapy http://pogp.csp.org.uk/	(J. H. Cole, 1983)

Appendix 2: The number of research papers retrieved from the Google Scholar and PubMed search engines for the various search terms

	anatomy physiotherapy pedagogy teaching curriculum education	anatomy physiotherapy teaching	anatomy physiotherapy approaches	anatomy physiotherapy teaching approach	anatomy physiotherapy learning approach	anatomy physiotherapy learning strategy	anatomy physiotherapy philosophy teaching	anatomy physiotherapy teaching theory
	A	B	C	D	E	F	G	H
Google Scholar 1600 articles	First 200/ 3,370 results	First 200/ 24,300 results	First 200/ 32,400 results	First 200/ 20,600 results	First 200/ 21,900 results	First 200/ 19,300 results	First 200/ 17,500 results	First 200/ 17,600 results
PubMed 1384 articles	43 articles	882 articles	309 articles, of which none was relevant	64 articles	22 articles	11 articles, of which none was relevant	36 articles, of which none was relevant	17 articles, of which none was relevant
Total of 2984 articles								

Appendix 3: The list of papers on teaching or learning anatomy for physiotherapy from the literature search

Abbreviations for the Table below

Que = Used Questionnaire **Met** = Type of methodology (Quantitative or Qualitative) **Phi** = Philosophy/thinking approach
Con = anatomical content **Hu** = Human resource **Tea** = Teaching aid **Y** = Yes **Refs** = Obtained from References of initial articles **Quant** = Quantitative research **Qual** = Qualitative research **Delphi** = Delphi methodology

Colour Codes for the Table below

Green = Yes	Light Green = Survey	Grey = Quantitative study	Light blue = Qualitative Study	Purple = Non-Quantitative and non-Qualitative studies

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
Articles examined							200	200	200	200	200	200	200	200	43	882	309	34	22	11	36	17
1. Meyer, J. J., Obmann, M. M., Gießler, M., Schuldis, D., Brückner, A. K., Strohm, P. C., ... & Spittau, B. (2017). Interprofessional approach for teaching functional knee joint anatomy. Annals of Anatomy-Anatomischer Anzeiger, 210, 155-159.	Y	Quant		Y					Y	Y					Y	Y						
2. Ferrer-Torregrosa, J., Jiménez-Rodríguez, M. Á., Torralba-Estelles, J., Garzón-Farinós, F., Pérez-Bermejo, M., & Fernández-Ehrling, N. (2016). Distance learning ECTS and flipped classroom in the anatomy learning: comparative study of the use of augmented reality, video and notes. BMC Medical Education, 16(1), 230.	Y	Quant			Y										Y	Y						
3. Sander, O., Schmidt, R., Rehkämper, G., Lögters, T., Zilkens, C., & Schneider, M. (2016). Interprofessional education as part of becoming a doctor or physiotherapist in a competency-based curriculum. GMS Journal for Medical Education, 33(2), Doc15.	Y	Quant		Y				Y	Y	Y	Y				Y	Y		Y	Y			
4. Green, R. A., & Whitburn, L. Y. (2016). Impact of introduction of blended learning in gross anatomy on student outcomes. Anatomical Sciences Education, 9(5), 422-430.	Y	Quant			Y						Y	Y			Y	Y						
5. de Oliveira, C. A. M., de França Carvalho, C. P., Céspedes, I. C., de Oliveira, F., & Sueur-Maluf, L. (2015). Peer mentoring program in an interprofessional and interdisciplinary curriculum in Brazil. Anatomical Sciences Education, 8(4), 338-347.	Y	Quant		Y											Y							
6. Khan, M. S. G., ul Ain, Q., Hussan, S. I., Basher, S., Iram, H., & Umar, B. (2015). Opinion of Pakistani physiotherapists/students about anatomy as a subject and method of teaching anatomy: A cross-sectional survey. Journal of the Pakistan Medical Association, 65(2), 153-155.	Y (Survey)	Quant			Y							Y			Y	Y						
7. Kotzé, S. H., & Mole, C. G. (2015). Making large class basic histology lectures more interactive: The use of draw-along mapping techniques and associated educational activities. Anatomical Sciences Education, 8(5), 463-470.	Y	Quant			Y										Y	Y						
8. Green, R. A., Farchione, D., Hughes, D. L., & Chan, S. P. (2014). Participation in asynchronous online discussion forums does improve student learning of gross anatomy. Anatomical sciences education, 7(1), 71-76.	Y	Quant			Y			Y		Y	Y			Y	Y							

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
9. Anyanwu, E. G., Obikili, E. N., & Agu, A. U. (2014). The dissection room experience: A factor in the choice of organ and whole body donation - A Nigerian survey. Anatomical Sciences Education, 7(1), 56-63.	Y	Quant			Y										Y							
10. Green, R. A., & Hughes, D. L. (2013). Student outcomes associated with use of asynchronous online discussion forums in gross anatomy teaching. Anatomical Sciences Education, 6(2), 101-106.	Y	Quant			Y			Y	Y	Y	Y	Y		Y	Y	Y						
11. Phillips, D. R., Barnard, S., Mullee, M. A., & Hurley, M. V. (2009). Simple anatomical information improves the accuracy of locating specific spinous processes during manual examination of the low back. Manual Therapy, 14(3), 346-350.		Quant			Y			Y							Y							
12. Gangata, H. (2008). An innovative approach to supplement the teaching of the spatial gross anatomy relationships of muscles to undergraduates in health sciences. Clinical Anatomy, 21(4), 339-347.	Y (Survey)	Quant			Y			Y	Y	Y	Y			Y	Y	Y		Y	Y			
13. Mitchell, B. S., McCrorie, P., & Sedgwick, P. (2004). Student attitudes towards anatomy teaching and learning in a multiprofessional context. Medical Education, 38(7), 737-748.	Y	Quant			Y				Y		Y				Y	Y						
14. Latman, N. S., & Lanier, R. (2001). Gross anatomy course content and teaching methodology in allied health: Clinicians' experiences and recommendations. Clinical Anatomy, 14(2), 152-157.	Y (Survey)	Quant	Con					Y							Y	Y						
15. Mattingly, G. E., & Barnes, C. E. (1994). Teaching human anatomy in physical therapy education in the United States: A survey. Physical Therapy, 74(8), 720-727.	Y (Survey)	Quant	Con												Y	Y						
16. McGown, H. L., & Faust, G. W. (1971). Computer-assisted instruction in physical therapy: A pilot program. Physical Therapy, 51(10), 1113-1120.	Y	Quant			Y		Y								Y	Y						
17. Darcus, H., & Wynn, P. C. (1955). Anatomy and physiology in the teaching and practice of physiotherapy and occupational therapy. Rheumatology, 2(7), 242-247.		Commentary	Con		Y			Y							Y	Y						
18. Plack, M. M. (2000). Computer-assisted instruction versus traditional instruction in teaching human gross anatomy. Journal of Physical Therapy Education, 14(1), 38-43.	Y	Quant			Y		Y	Y		Y												
19. Hoang, T., Reinoso, M., Joukhadar, Z., Vetere, F., & Kelly, D. (2017, May). Augmented Studio: Projection mapping on moving body for physiotherapy education. In Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems (pp. 1419-1430). Association for Computing Machinery.	Y	Quant			Y		Y			Y				Y								
20. Gazula, S., McKenna, L., Cooper, S., & Paliadelis, P. (2017). A systematic review of reciprocal peer tutoring within tertiary health profession educational programs. Health Professions Education. Ahead of Press		Systematic review		Y			Y															
21. Mehta, H., & Rouf, A. (2013). Pedagogical approaches to enhance student learning in the new inter-professional health science units at the Australian Catholic University. Journal of Modern Education Review, 3(3), 250-255		Quant			Y		Y															
22. Osinubi, A. A., & Ailoje-Ibru, K. O. (2014). A paradigm shift in medical, dental, nursing, physiotherapy and pharmacy education: From traditional method of teaching to case-based method of learning - A review. Annual Research and Review in Biology, 4(13), 2053-2072.		Systematic review			Y		Y	Y		Y	Y	Y		Y								

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
23. Dulloo, P., Vedi, N., & Gandotra, A. (2016). Life Orientation Test-Revised (LOT-R) Versus Academic Score in various first year health professional students. Journal of Clinical and Diagnostic Research, 10(10), CC01.		Quant		Y														Y				
24. Fernandes, A. R., Palombella, A., Salfi, J., & Wainman, B. (2015). Dissecting through barriers: A mixed-methods study on the effect of interprofessional education in a dissection course with healthcare professional students. Anatomical Sciences Education, 8(4), 305-316.	Mixed methods	Both Quant & Qual		Y												Y		Y	Y			
25. Shead, D., Roos, R., Olivier, B., & Ihunwo, A. O. (2016). Gross anatomy curricula and pedagogical approaches for undergraduate physiotherapy students: A scoping review protocol. JBI Database of Systematic Reviews and Implementation Reports, 14(10), 98-104.		Systematic review	Y	Y	Y				Y	Y		Y		Y		Y						
26. Fabrizio, P. A. (2013). Oral anatomy laboratory examinations in a physical therapy program. Anatomical Sciences Education, 6(4), 271-276.	Y	Quant			Y											Y						
27. Nanjundaiah, K., & Chowdapurkar, S. (2012). Body-painting: A tool which can be used to teach surface anatomy. Journal of clinical and diagnostic research: JCDR, 6(8), 1405.	Y	Quant			Y				Y		Y					Y						
28. Valenza, M. C., Castro-Martín, E., Valenza, G., Guirao-Piñeiro, M., De-la-Llave-Rincón, A. I., & Fernández-de-las-Peñas, C. (2012). Comparison of third-year medical and physical therapy students' knowledge of anatomy using the carpal bone test. Journal of Manipulative and Physiological Therapeutics, 35(2), 121-126.	Y	Quant			Y											Y						
29. Krause, D. A., Youdas, J. W., & Hollman, J. H. (2011). Learning of musculoskeletal ligament stress testing in a gross anatomy laboratory. Anatomical Sciences Education, 4(6), 357-361.	Y	Quant			Y											Y						
30. Silén, C., Wirell, S., Kvist, J., Nylander, E., & Smedby, Ö. (2008). Advanced 3D visualization in student-centred medical education. Medical Teacher, 30(5), e115-e124.	Y	Quant			Y											Y						
31. Bukowski, E. L., Jensen, R. H., & Morrison, M. A. (1980). Comparison of textbook and self-instructional learning methods. Physical Therapy, 60(2), 179-183.	Y	Quant			Y											Y						
32. Milacek, B., Pedersen, B. (1967). Anatomy courses in physical therapy; A survey. Physical Therapy, 47(4), 289-291	Y	Quant			Y											Y						
33. Gunn, H., Hunter, H., & Haas, B. (2012). Problem Based Learning in physiotherapy education: a practice perspective. Physiotherapy, 98(4), 330-335.		Qual	Y						Y													
34. McLachlan, J. C., Bligh, J., Bradley, P., & Searle, J. (2004). Teaching anatomy without cadavers. Medical Education, 38(4), 418-424.		Commentary			Y				Y													
35. Titchen, A. (1992). An investigation of physiotherapy students' approaches to their study in UK hospital, polytechnic-based and university-linked schools. Physiotherapy, 78(7), 490-494.	Y (Survey)	Quant	Y						Y													
36. Arroyo-Morales, M., Cantarero-Villanueva, I., Fernández-Lao, C., Guirao-Piñeyro, M., Castro-Martín, E., & Díaz-Rodríguez, L. (2012). A blended learning approach to palpation and ultrasound imaging skills through supplementation of traditional classroom teaching with an e-learning package. Manual Therapy, 17(5), 474-478.	Y	Quant			Y			Y	Y	Y	Y	Y		Y								
37. Williams, J. M. (2014). Is student knowledge of anatomy affected by a Problem-Based Learning approach? A Review. Journal of Education and Training Studies, 2(4), 108-112.		Systematic review	Y					Y	Y					Y								

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
38. Diaz, C. M., & Woolley, T. (2015). Engaging multidisciplinary first year students to learn anatomy via stimulating teaching and active, experiential learning approaches. Medical Science Educator, 25(4), 367-376.	Y	Mostly Quant ,minor Qual			Y			Y	Y	Y	Y	Y	Y									
39. Agnihotri, G., & Kalyan, G. S. (2013). Anatomy teachers' perspective of augmentation of student interest and aptitude using multimedia versus problem based learning in physiotherapy teaching - A qualitative pilot study. Journal of Physical Therapy, 6(2), 46-53.	Y (Survey)	Quant	Y					Y	Y	Y	Y			Y								
40. Brook, N., & Parry, A. (1985). The influence of higher education on the assessment of students of physiotherapy. Assessment and Evaluation in Higher Education, 10(2), 131-145.		Comm entary	Con		Y				Y													
41. Mącznik, A. K., Ribeiro, D. C., & Baxter, G. D. (2015). Online technology use in physiotherapy teaching and learning: A systematic review of effectiveness and users' perceptions. BMC Medical Education, 1(15), 1-12.		Syste matic review			Y			Y	Y		Y	Y										
42. Dayal, M. R., Owens, J., Gibson, W., & Štrkalj, G. (2017). Anatomical knowledge retention in physiotherapy students: a preliminary assessment. International Journal of Anatomy and Research, 5(1), 3474-79.		Quant	Y						Y	Y		Y										
43. Melguizo, C., Prados, J., Rodriguez-Serrano, F., Hita, F., Peran, M., Boulaiz, H., ... & Martínez, A. (2007). Anatomy teaching to physiotherapy students: Preliminary study in the European higher education area setting. European Journal of Anatomy, 11(S1), 59-61.	Y (Survey)	Quant			Y			Y	Y	Y	Y	Y		Y								
44. Aragão, J. A., Fonseca-Barreto, A. T., Brito, C. J., Guerra, D. R., Nunes-Mota, J. C., & Reis, F. P. (2012). The availability of teaching-pedagogical resources used for promotion of learning in teaching human anatomy. Advances in medical education and practice, 4, 157-163.	Y	Quant			Y			Y		Y	Y			Y								
45. Prithishkumar, I. J., & Holla, S. J. (2012). Early clinical exposure as a teaching learning tool to teach neuroanatomy for first year occupational and physical therapy students–our preliminary experience. Indian Journal of Physiotherapy and Occupational Therapy, 6(2), 59-62.	Y	Quant			Y			Y		Y	Y	Y										
46. Lee, H. B. (1996). A comparative analysis of lectures versus interactive computer-assisted learning packages for the teaching and learning of anatomy by tertiary students. PhD Thesis Curtin University. Faculty of Education.	Y	Quant			Y			Y		Y	Y	Y										
47. Smith, C. F., Hall, S., Border, S., Adds, P. J., & Finn, G. M. (2015). Interprofessional anatomy education in the United Kingdom and Ireland: Perspectives from students and teachers. Anatomical Sciences Education, 8(4), 360-370.	Y	Mostly Quant & minor Qual		Y				Y		Y	Y			Y								
48. Donovan, M. (1994). Anatomy results in occupational therapy and physiotherapy: Why the Discrepancy? British Journal of Occupational Therapy, 57(6), 224-227.	Y	Quant						Y		Y	Y	Y										
49. McLean, A. J., Bond, C. H., & Nicholson, H. D. (2015). An anatomy of feedback: a phenomenographic investigation of undergraduate students' conceptions of feedback. Studies in Higher Education, 40(5), 921-932.	Phenom enology	Qual		Y						Y	Y		Y									

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
50. Parmar, S. K., & Rathinam, B. A. (2011). Introduction of vertical integration and case-based learning in anatomy for undergraduate physical therapy and occupational therapy students. Anatomical Sciences Education, 4(3), 170-173.	Y	Quant			Y			Y		Y	Y	Y										
51. O'Brien, D., Caldwell, J., Culav, E., & Clark, H. (2015). Perceived value of online video demonstrations as an adjunct to learning surface anatomy for physiotherapy students. Focus on Health Professional Education: A Multi-Professional Journal, 16(4), 82-85.					Y			Y		Y												
52. Ghorbani, N., Karbalay-Doust, S., & Noorafshan, A. (2014). Is a team-based learning approach to anatomy teaching superior to didactic lecturing?. Sultan Qaboos University Medical Journal, 14(1), e120.	Y	Quant		Y						Y		Y		Y								
53. Speed, C. J., Kleiner, A., & Macaulay, J. O. (2015). Broadening student learning experiences via a novel cross-disciplinary art and anatomy education program - A Case Study. International Journal of Higher Education, 4(1), 86-91.	Y	Quant			Y					Y												
54. Moraes, G., Falcão, J., Sandes, A., Rodrigues, B., Nascimento, I., Schwingel, P., & Silva Júnior, E. X. (2016). Cadaveric dissection by students-monitors in human anatomy discipline: experience report. Journal of Morphology, 33(2), 68-72.	Phenom enology	Qual			Y					Y		Y										
55. Cantarero-Villanueva, I., Fernández-Lao, C., Galiano-Castillo, N., Castro-Martín, E., Díaz-Rodríguez, L., & Arroyo-Morales, M. (2012). Evaluation of e-learning as an adjunctive method for the acquisition of skills in bony landmark palpation and muscular ultrasound examination in the lumbopelvic region: a controlled study. Journal of Manipulative and Physiological Therapeutics, 35(9), 727-734.	Y	Quant			Y						Y	Y										
56. Moore, C., Westwater-Wood, S., & Kerry, R. (2016). Academic performance and perception of learning following a peer coaching teaching and assessment strategy. Advances in Health Sciences Education, 21(1), 121-130.	Y	Quant		Y							Y	Y										
57. Walker, R., Spronken-Smith, R., Bond, C., McDonald, F., Reynolds, J., & McMartin, A. (2010). The impact of curriculum change on health sciences first year students' approaches to learning. Instructional Science, 38(6), 707-722.	Y	Quant									Y											
58. Youdas, J. W., Krause, D. A., Hellyer, N. J., Rindflesch, A. B., & Hollman, J. H. (2013). Use of individual feedback during human gross anatomy course for enhancing professional behaviours in doctor of physical therapy students. Anatomical Sciences Education, 6(5), 324-331.	Y (Survey)	Quant			Y							Y	Y									
59. Thomson, D., Boyle, D., Legg, C., Owen, M., Newman, M., & Cole, M. J. (2016). Clinical placements: the perspectives of UK physiotherapy students on how prepared they were by their university for their first clinical placements: an example of one HEI. International Journal of Practice-based Learning in Health and Social Care, 2(1), 69-79.	Y (Survey)	Quant			Y							Y										
60. Veneri, D. (2011). The role and effectiveness of computer-assisted learning in physical therapy education: a systematic review. Physiotherapy Theory and Practice, 27(4), 287-298.		Syste matic review			Y							Y										

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
61. Cooper, V., & McConnell, M. (2000). Development of a Web-based learning tool for undergraduate health professionals studying applied anatomy. Association for Learning Technology Journal, 8(1), 62-70.	Y	Quant			Y							Y										
62. Prados, J., Melguizo, C., Rodriguez-Serrano, F., Velez, C., Hita, F., Peran, M., ... & Marchal, J. A. (2017). Methodology in the European higher education area for the Anatomy learning in the Health Sciences. European Journal of Anatomy, 11(S1), 49-52.	Y (Survey)	Quant						Y				Y		Y								
63. Ryan, J. M. (2011). Students' perceptions of peer learning in an undergraduate physiotherapy programme. Bachelor's thesis, Department of Physiotherapy. University of Limerick).	Y	Mostly Quant & minor Qual		Y								Y										
64. Roberts, F. E. (2015). Student views of using e-learning tools to facilitate independent learning of anatomy and physiology. Journal of Learning Development in Higher Education, (9), 1-22.	Y	Mostly Quant & minor Qual			Y							Y										
65. Brown, S., White, S., & Power, N. (2016). Cluster analysis of assessment in anatomy and physiology for health science undergraduates. International Journal of Teaching and Learning in Higher Education, 28(1), 102-109.	Y	Quant			Y							Y										
66. Nicholson, L. L., Reed, D., & Chan, C. (2016). An interactive, multi-modal Anatomy workshop improves academic performance in the health sciences: a cohort study. BioMedCentral Medical Education, 16, 7.	Y	Mostly Quant & minor Qual			Y							Y										
67. Lee, H. B., & Allison, G. (1992). A comparative study of the presentation of anatomy by lectures versus ICAL packages to physiotherapy students. In Proceedings of the International Interactive Multimedia Symposium (pp. 235-245).	Y	Quant			Y			Y						Y								
68. Aragão, J. A., Fonseca-Barreto, A. T., Brito, C. J., Guerra, D. R., Nunes-Mota, J. C., & Reis, F. P. (2013). The availability of teaching-pedagogical resources used for promotion of learning in teaching human anatomy. Advances in Medical Education and Practice, 4, 157-163.	Y (Survey)	Quant			Y									Y								
69. Farrell, S. F., Davies, T. M., & Cornwall, J. (2015). Use of clinical anatomy resources by musculoskeletal outpatient physiotherapists in Australian public hospitals: a cross-sectional study. Physiotherapy Canada, 67(3), 273-279.	Y	Qual			Y			Y						Y								
70. Rabbo, F. A., Garrigues, F., Lefèvre, C., & Seizeur, R. (2016). Interactive anatomical teaching: Integrating radiological anatomy within topographic anatomy. Morphologie, 100(328), 17-23.	Y (Survey)	Quant			Y									Y								
71. Díaz-Mancha, J. A., Castillo-López, J. M., Munuera-Martinez, P. V., Fernández-Seguín, L. M., Polo-Padillo, J., & Heredia-Rizo, A. M. (2016). A comparison of fourth-year health sciences students' knowledge of gross lower and upper limb anatomy: A Cross-sectional study. Journal of Manipulative and Physiological Therapeutics, 39(6), 450-457.	Y	Quant			Y									Y								

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
72. Hancock, D., Williams, M., & Taylor, A. (1998). Psychological impact of cadavers and prosections on physiotherapy and occupational therapy students. Australian Journal of Physiotherapy, 44(4), 247-255.	Y	Quant			Y			Y														
73. Cooper, V., & McConnell, M. (2000). Development of a Web-based learning tool for undergraduate health professionals studying applied anatomy. Association for Learning Technology Journal, 8(1), 62-70.	Y	Quant			Y			Y														
74. Wirz, P., & Jakob, R. P. (1999). Knee joint simulator: an anatomical reconstruction of the joint surfaces and of the ligamentous structures of the knee joint for teaching purposes. Knee Surgery, Sports Traumatology, Arthroscopy, 7(1), 59-62.		Technical description			Y			Y														
75. Huitt, T. W., Killins, A., & Brooks, W. S. (2015). Team-based learning in the gross anatomy laboratory improves academic performance and students' attitudes toward teamwork. Anatomical Sciences Education, 8(2), 95-103.	Y	Quant			Y	Y																
76. Armstrong, D. L., & Rosser, B. W. (1996). A survey comparing human gross anatomy courses for physical therapy students in Canada and the United States. Physiotherapy Canada, 48(3), 185-189.	Y (Survey)	Quant			Y	Y				Y												
77. Bukowski, E. L., Jensen, R. H., & Morrison, M. A. (1980). Comparison of textbook and self-instructional learning methods. Physical Therapy, 60(2), 179-183.	Y	Quant			Y	Y																
78. Saarlnen, H., & Salvatori, P. (1994). Educating occupational and physiotherapists for the year 2000: What, no anatomy course?. Physiotherapy Canada, 46(2), 81-88.		Commentary				Y																
79. Livingston, B., Lundy, M., & Harrington, S. (2014). Physical therapy students' perceptions of team-based learning in gross anatomy using the Team-Based Learning Student Assessment Instrument. Journal of Educational Evaluation for Health Professions, 11(1), 1-10.	Y	Quant		Y		Y																
80. Thomas, K. J., Denham, B. E., & Dinolfo, J. D. (2011). Perceptions among occupational and physical therapy students of a non-traditional methodology for teaching laboratory gross anatomy. Anatomical Sciences Education, 4(2), 71-77.	Y	Quant			Y	Y																
81. Killins, A. M. (2015). Team-based learning in a physical therapy gross anatomy course. University of Central Arkansas. PhD Thesis	Y	Mostly Quant & minor Qual		Y		Y																
82. Westwater-Wood, S., & Moore, C. (2016). Podcasting of practical summative assessment feedback: An evaluation of practice. MedEdPublish, (5).	Y	Quant				Y																
83. Foreman, K. B., Morton, D. A., Musolino, G. M., & Albertine, K. H. (2005). Design and utility of a web-based computer-assisted instructional tool for neuroanatomy self-study and review for physical and occupational therapy graduate students. The Anatomical Record, 285(1), 26-31.	Y	Quant			Y	Y																

						Refs	Google Scholar Searches								PubMed Searches							
	Que	Met	Phi/ Con	Hu	Tea		A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
84. Berube, D., Murray, C., & Schultze, K. (1999). Cadaver and computer use in the teaching of gross anatomy in physical therapy education. Journal of Physical Therapy Education, 13(2), 41-46.	Y	Quant			Y	Y																
85. McKenzie, A. L., & Gutierrez, B. (2007). The varied-integrative-progressive (VIP) model for anatomy instruction in physical therapist education. Journal of Physical Therapy Education, 21(2), 17-29.	Y	Quant			Y	Y																
86. Yeager, V. L. (1996). Learning gross anatomy: dissection and prosection. Clinical Anatomy, 9(1), 57-59.		Quant			Y	Y																
87. Bukowski, E. L. (2002). Assessment outcomes: Computerized instruction in a human gross anatomy course. Journal of Allied Health, 31(3), 153-158.	Y	Quant			Y	Y																
88. Lake, D. A. (1999). Enhancement of student performance in a gross anatomy course with the use of peer tutoring. Journal, Physical Therapy Education, 13(1), 34-38.	Y	Quant		Y		Y																
89. Youdas, J. W., Krause, D. A., Hellyer, N. J., Hollman, J. H., & Rindflesch, A. B. (2007). Perceived usefulness of reciprocal peer teaching among doctor of physical therapy students in the gross anatomy laboratory. Journal of Physical Therapy Education, 21(2), 30-38.	Y	Quant		Y		Y																
90. Saarlnen, H., & Salvatori, P. (1994). Educating occupational and physiotherapists for the year 2000: What, no anatomy course?. Physiotherapy Canada, 46(2), 81-88.		Comm entary				Y																
91. Anderson, J. C., & Conley, L. K. (2000). Retention of anatomical detail. Journal of Physical Therapy Education, 14(1), 44-47.		Quant				Y																
92. Fiebert, I. M., & Waggoner, P. (1996). Retention of gross anatomy knowledge by physical therapy students. Journal of Physical Therapy Education, 10, 82-84. Could not be retrieved						Y																
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Appendix 4: Examples of multimedia principles of the 4CID theory

Examples of Prominent Multimedia Principles for Each of the Four Components of the 4C/ID-Model

Multimedia Principle	Example
Learning Tasks and Learning in Simulated Task Environments	
1. Sequencing principle	For physics students who learn to troubleshoot electrical circuits, start with circuits with only very few elements (e.g., a lamp, battery and switch) and continue with circuits with increasingly more elements.
2. Fidelity principle	For medical students who learn to diagnose patients, start with textual case descriptions, continue with computer-simulated patients or patients played by peers, go on with simulated patients played by actors, and end with real patients in an internship in hospital.
3. Variability principle	For law students who learn to prepare pleas to be held in court, make sure that learning tasks ask them to prepare pleas for different fields of law (civil law, criminal law), different clients (guilty, not guilty), different courts (police court, law court, supreme court), and so on.
4. Individualization principle	For computer science students who learn to write computer programs, continuously assess with which programming constructs they have difficulties and select new learning tasks that offer optimal opportunities to remedy their misconceptions.
5. Training-wheels principle	For accountancy students who learn to make budgets with a spreadsheet program, first block all toolbars and menu options that are not strictly necessary to perform the task, but only add these when they become necessary because students progress to making more complex budgeting tasks.
6. Completion-strategy principle	For students in architecture who learn to design constructional blueprints, first let them evaluate the qualities of blueprints of existing buildings, then let them redesign blueprints for the renovation of buildings, and finally let them design blueprints for new buildings.
Supportive Information and Learning from Hypermedia	
7. Redundancy principle	For students in econometrics who learn to explain periods of economic growth, first present a qualitative model (allows them to predict if there will be any growth) and only then present a more encompassing quantitative model (laws that may help them to compute the amount of growth) – but *without* repeating the qualitative information as such.
8. Self-explanation principle	For medical students who learn to diagnose malfunctions in the human cardiovascular system, present an animation of how the hart works and provide prompts that provoke them to explain the underyling mechamisms to themselves or their peers.
9. Self-pacing principle	For students in psychotherapy who learn to conduct intake conversations with depressed clients, show video-examples of real-life intake conversations and give them the opportunity to stop/replay the recording after each segment in order to reflect on this particular segment.
Procedural Information and Electronic Performance Support Systems	
10. Temporal split-attention principle	For students in web design who learn to develop web pages in a new software environment, tell them how to use the different functions of the software environment precisely when they need them to implement particular aspect of their design – instead of discussing all available functions beforehand.
11. Spatial split-attention principle	For social science students who learn to conduct statistical analyses on their data files with SPSS, present procedural information describing how to conduct a particular analysis also on the computer screen and not in a separate manual.
12. Signaling principle	For students in car engineering who learn to disassemble an engine block, animate the disassembling process in a step-by-step fashion and always put a spotlight on those parts that are loosened and removed.
13. Modality principle	For students in instructional design who learn to develop training blueprints by studying a sequence of more and more detailed blueprints, explain the blueprints with narration or spoken text instead of visual (on-screen) text.
Part-task Practice and Drill & Practice CBT Programs	
14. Component-fluency principle	For students in air traffic control who learn to direct incoming aircraft, provide additional and extensive part-task practice on immediately recognizing potentially dangerous air traffic situations from the radar screen.

The table was copied from Mayer, 2014a.

Appendix 5: Approval of the Research Proposal for the current study

From: SHEMILT Jennifer <J.Shemilt@staffs.ac.uk>
To: Hope Gangata <hopegata@yahoo.co.uk>
Cc: VIGURS Katy E <K.Vigurs@staffs.ac.uk>; BOLTON Cheryl <C.Bolton@staffs.ac.uk>
Sent: Thursday, 29 October 2015, 13:07
Subject: RDC1 application
Mr Hope Gangata

Dear Hope
Re: RDC1 - Application to register for a Professional Doctorate
With reference to your above application which was considered by the Faculty's Research Degrees Sub-Committee on 28th October 2015, your registration was approved.

Date and period of registration:

Start date:	1st September 2015 (as requested on the application)
Mode of study:	Part Time
Supervision team:	Principal Supervisor – Dr Katy Vigurs
	Second Supervisor - Dr. Cheryl Bolton

Title of Research Project: An investigation of the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study.

Finally, on behalf of the Committee, may I take this opportunity to wish you every success with your research project.

Yours sincerely
Jenny Shemilt
Research Degrees Administrator
Faculty of Business, Education & Law
Staffordshire University
B227 Brindley Building
Leek Road
Stoke on Trent
Staffordshire
ST4 2DF
T: 01782 294147
E: j.shemilt@staffs.ac.uk

Appendix 6: The Pre-Pilot Interview Schedule

The Pre-Pilot Interview Schedule

For the Research Topic:

An investigation into the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study

The following 'Interview Schedule' will be a guideline and not a prescription schedule. There will be full exploration of ideas with neutral questions.
The interview will broadly be organised in the following order:

A. **Greetings and Introductions**

B. **Brief Summary of Research project by the researcher**

C. **Clarifying any concerns the participant might have and Confirmation of signing the Consent Form**

D. **Clarifying questions stemming from the Demographic Pre-Interview Questionnaire**

E. **The two main research questions will be:**
   1. **Current teaching and learning:** What are the current main pedagogical principles of your teaching of anatomy for physiotherapy
   2. **Ideal teaching and learning:** What are your ideal main pedagogical principles for your teaching of anatomy for physiotherapy

   Each of the two main questions will have five follow-on sub-questions to help fully explore the ideas from the participants and these are:
   i. How are the main pedagogical principles or characteristics related?
   ii. How do the main pedagogical principles or characteristics influence the planning, delivery and assessment and evaluation of teaching and learning anatomy for physiotherapy?
   iii. How do the main pedagogical principles or characteristics influence the quality and number of teaching, technical and administrative staff, the type and design of building resources, time and learning resources?
   iv. By what standards would you judge that your teaching of anatomy will effective five years after the graduation of your students?
   v. How do your main pedagogical principles or characteristics influence your research activities?

F. **Thanking the participant for participating in the study**

Appendix 7: The Post-Pilot Interview Schedule

The Post-Pilot Interview Schedule

For the Research Topic:
An investigation into the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study

The following 'Interview Schedule' will be a guideline and not a prescription schedule. There will be full exploration of ideas with neutral questions.

The interview will broadly be organised in the following order:
A. Greetings and Introductions

B. Brief Summary of Research project by the researcher

C. Clarifying any concerns the participant might have and Confirmation of signing the Consent Form

D. Clarifying questions stemming from the Demographic Pre-Interview Questionnaire

E. Research questions in laymen's terms and in a less intimidating manner (and this is how they will be asked)

1. What are your thoughts on anatomical teaching and learning for physiotherapy? (Icebreaker Question)

For the following questions, I will define 'educational principles' to the participants as 'concepts and theories of learning that teachers use to underpin their approach to teaching. These 'educational principles' could have been invented by them or imported from elsewhere.

2. To help the long term learning of anatomy in physiotherapy students;
    a. What are the teaching and learning 'educational principles' you use?
    b. Ask for clarifications of their 'educational principles'
    c. How do the 'educational principles' translate to practical classroom activities?
    d. What are the sources of their 'educational principles'?
    3. How are the 'educational principles' related to each other?
4. How would the 'educational principles' influence, alter or modify the;
    a. planning, delivery, assessment and evaluation of teaching and learning anatomy for physiotherapy
    b. use of resources such as staffing, use of buildings, time, learning resources
5. How would you assess the effectiveness of these 'educational principles' five years after graduation?
6. To what extent have you actually implemented the 'educational principles'?

F. **Thanking the participant for participating in the study**

Appendix 8: Confirmation of Booking the Nvivo Training session

-----Original Message-----
From: uob-tsdt [mailto:ittc@lists.bham.ac.uk]
Sent: 11 November 2015 09:52
To: GangataH@bham.ac.uk
Subject: Course Booking Confirmation - An Introduction to QSR NVivo - Part 2

This is to confirm your booking on the following course:
COURSE TITLE: An Introduction to QSR NVivo - Part 2
COURSE DATE AND TIME: Wed 18/11/2015 11:00 to 12:50
VENUE: Room G11, Nuffield Learning Centre
R9 on map at http://www.birmingham.ac.uk/Documents/university/edgbaston-map.pdf

CANCELLING YOUR BOOKING
If you are no longer able to attend the course, would you please cancel your booking so that the place can be made available to others. You may cancel up to one hour before the start of the course by logging in again at http://www.supersaas.co.uk/schedule/uob-tsdt/Nuffield_G11_Training_Room

COURSE CANCELLATIONS
Courses may occasionally be cancelled by us if booked attendees are not sufficient. If this should happen, we will inform you by email.

WEBSITE
Full details of our courses, including online courses, can be found on our website at https://intranet.birmingham.ac.uk/as/cladls/skills/index.aspx
Thank you.

Appendix 9: Research Information Sheet for Participants

Research Information Sheet for Participants

Research Topic: An investigation into the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study

I would like to invite you to take part in my research work that is a part-fulfilment of my Doctorate in Education (EdD) degree at the University of Staffordshire. The 'Consent Form' and 'Research Information Sheet for Participants' have followed the Research Ethical Guidelines of the British Educational Research Association.

Who is organising and funding this assignment?
My name is Mr Hope Gangata and I am self-funding the study. I am a registered Physiotherapist who is currently working as an Anatomy Lecturer at the University of Birmingham.

What is the study about?
Physiotherapy has experienced profound development and growth, especially in the last three decades, to become one of the largest allied health professions in developed countries, but has a number of problems facing the teaching of its anatomy courses. The basis for selecting anatomical content to underpin the 40 areas of physiotherapy sub-specialisms in the UK is poorly known. There are no anatomy books with physiotherapy clinical examples across the many areas of physiotherapy sub-specialisms, resulting in physiotherapy students using anatomy textbooks meant for medical students. Even if the content is agreed upon, how that content is taught in the UK is vague. The aim of the study, therefore, is to determine a new educational theory that explains current and ideal dominant principles that anatomy teachers for physiotherapy use to promote long term learning of anatomy in students.

Why have I been invited?
You have been invited because you are a qualified physiotherapist who is teaching anatomy to physiotherapy students in the UK and you have a wealth of knowledge that could clarify how anatomy is being taught and could be improved.

What will happen to me if I take part?
Participation in the study will be in two stages: an exploratory Pre-Interview Questionnaire that will be emailed to all participants and research interviews with selected participants.

You will be asked to fill in an exploratory Pre-Interview Questionnaire to examine the teaching profiles and numbers of anatomy teachers for physiotherapy in the UK in general. My supervisors and I will then sit down after receiving back the completed forms and decide on which strategic and particular demographic groups of anatomy teachers that will be interviewed.

The selected interview participants will be further invited to participate in the research interviews, lasting between one and two hours, with the researcher that will be arranged at a time that is convenient for you. I will travel to you from Birmingham if you are based less than 150 miles from Birmingham or use Skype interviews for participants who are over 150 miles away.

Do I have to take part?
No, you do not have to take part. Taking part in this study is voluntary. You are allowed to omit questions you do not want to answer. You can withdraw from the study at any

time before when the data is aggregated and anonymised (a few weeks after the interview).

What are the possible benefits of taking part in this study?
The participants will benefit from being stimulated by the interview discussions to reflect on their teaching approaches of anatomy for physiotherapy students. There are also broader benefits of the study. The research will shed light on how anatomy for physiotherapy is being taught and could be improved in the UK, a neglected area in literature. The new theory will indicate how human resources, physical resources, reading materials and time could be most effectively aligned during the planning, teaching and assessment of anatomical teaching for physiotherapy in the UK. Ultimately, patients in the UK could benefit from being treated by physiotherapists with better anatomical knowledge.

What are the possible disadvantages and risks of taking part in this study?
There are no foreseen risks.

Will it cost me anything?
No.

What happens when the interview finishes?
The interview will be digitally recorded, anonymised and transcribed by the researcher. It will be analysed and reported, but you will not be identifiable from the published dissertation. Your identity will only be known to me. The digital recordings and the transcripts will be stored securely for 10 years, and destroyed thereafter.

Who has reviewed the study?
The study was reviewed and approved by the Faculty of Business, Education and Law Research Ethics Committee of the University of Staffordshire, UK.

Further information
If you are interested in participating, please complete and return the attached 'Consent Form'. For any further questions, please contact:

Mr Hope Gangata — BSc Hons Intercalated Human Anatomy (2001), BSc Hons Physiotherapy (2003), Master of Medicine in Anatomy (2008), MA Higher Education Practice (2012), Fellow of the Higher Education Academy of UK & Doctoral Candidate EdD (University of Staffordshire)
Tel: 07958086787
Email: hopegata@yahoo.co.uk

In case you have any complaints about the research, you can contact my research supervisor Dr Katy Vigurs (http://www.staffs.ac.uk/staff/profiles/kv1.jsp) on:
Email address: k.vigurs@staffs.ac.uk

Thank you for taking the time to read this information sheet.

Appendix 10: Consent Form for the study

Consent Form for the study

Full title of Study:
An investigation into the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study

Name, position and contact address of Researcher:
Mr Hope Gangata
Anatomy Department
The Institute of Health and Biomedical Education
College of Medical and Dental Sciences
The University of Birmingham
Edgbaston, B15 2TT
Birmingham, United Kingdom
Tel: 07958086787
Email: hopegata@yahoo.co.uk

Please Initial Box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw, without giving reason. ☐
3. I agree that I can withdraw my data from the study up to the point before when the data is agregated and anonymised ☐
4. I agree to the interview / consultation being audio recorded ☐
5. I agree to the use of anonymised quotes in publications ☐
6. I agree to take part in the above study. ☐

Name of Participant	Date	Signature (Please type with a different font)
Name of Researcher	Date	Signature

Appendix 11: Pre-Interview Questionnaire Form

Pre-Interview Questionnaire Form

For the Study Entitled: **An investigation into the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study**

Question	Response	
Demographic Data		
1. Title		
2. Name and Surname		
3. Gender (Male/Female)		
4. University affiliated to		
5. Job title of current post		
6. Type of employment (Part-time/Full time)		
Physiotherapy Credentials		
1. Physiotherapy Qualifications & Year of completion		
2. Are you registered with the UK Health and Care Professions Council as a Physiotherapist? (Yes/No)		
3. During which period were you registered as Physiotherapist? (e.g. 2001 to 2015)	**From**	**To**
4. During which period did you practice physiotherapy clinically? (e.g. 2001 to 2015)	**From**	**To**
5. What are the area/s of physiotherapy specialisation/s you have qualifications for?		
6. What are the physiotherapy specialities you have clinical experiences in?		
7. What are the physiotherapy societies you are affiliated to?		
8. Are you involved in assessing the anatomical knowledge of physiotherapy students in clinical settings? (Yes/No)		
Anatomy Credentials		
1. Anatomy Qualifications & Year of completion		
2. What are the Pre-registration Physiotherapy degrees on which you teach anatomy?		
3. During which period did you teach anatomy to physiotherapy students? (e.g. 2001 to 2015)	**From**	**To**
4. What are the anatomical societies you are affiliated to?		
5. What are the teaching facilities you use to teach anatomy? (Please indicate with Yes/No on the options provided?)	• **Lecture venues** • **Tutorial Classrooms** • **Cadaveric material** • **Plastic anatomy models and skeletons**	

6. Do you have journal publications on anatomy? (Yes/No)	
7. Have you ever presented conference presentations on anatomy before (Yes/No)	
8. During which period have you taught anatomy?	**From** **To**
<u>Teaching Credentials</u>	
1. Teaching Qualifications & Year of completion	
2. What teaching societies are you affiliated to e.g. Fellowship with the Higher Education Academy	
3. Do you have journal publications on anatomical pedagogy? (Yes/No)	
4. Have you ever presented conference presentations on anatomical pedagogy before? (Yes/No)	
5. Have you written any anatomical learning material e.g. writing an anatomy textbook, student handouts, dissection instructions, tutorial handouts?	
6. What is your estimated number of hours spent teaching anatomy per week during busy periods? (Please indicate with Yes/No on the options provided?)	• **0-3 hours** • **3-10 hours** • **11-20 hours** • **20+ hours**
7. How is the anatomical curriculum divided into lectures, tutorials and practicals at your school? (Please indicate with Yes/No on the options provided?)	• Systematically (e.g. cardiovascular anatomy lecture, respiratory anatomy lecture etc.) • Regionally (e.g. upper limb lecture, lower limb lecture etc.) • Both systematically and regionally • Based on clinical cases (e.g. rheumatoid arthritis lecture, strokes lecture etc.) • Other
8. Do you use Problem-based Learning philosophy in teaching anatomy? (Yes/No)	
9. Do you use student-centred learning philosophy in teaching anatomy? (Yes/No)	
10. Do you use self-directed learning principles in teaching anatomy? (Yes/No)	
11. Do you use lifelong learning philosophy in teaching anatomy? (Yes/No)	
12. Do you teach anatomy formally in the clinical setting? (Yes/No)	
13. Do you provide enough opportunities for students to reflect on their learning of anatomy? (Yes/No)	
14. Do you promote the integration of anatomical knowledge with other physiotherapy subjects? (Yes/No)	
15. What assessment methods do you use for assessing anatomical knowledge in students? (Yes/No)	

Appendix 12: Letter of Ethical Approval to start research

STAFFORDSHIRE UNIVERSITY

Faculty of Business, Education and Law

Professor Susan K Foreman
MSc,PhD
Dean

Staffordshire University
Leek Road
Stoke-on-Trent ST4 2DF
United Kingdom

+44 (0) 1782 294000 (enquiries)
+44 (0) 1782 294907 (fax)
www.staffs.ac.uk

Hope Gangata
Postal address redacted

9 July 2015

ETHICAL APPROVAL FEEDBACK (proportionate review form)

Title of Study: **Doctor of Education Wider Participation in Learning**

Student name **Hope Gangata**

Status of Approval: **Approved Subject to further information approved by your Supervisor**

Title of Project: **An investigation into the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study.**

Your proposal contains areas that need further information. The amendments then need to be sent your Supervisor for approval.

1. On the parent's form a further box needs to be added whereby the participants should be able to withdraw their data up to the point that it has been aggregated and anonymised.

2. On the information sheet under "will my taking part in the study be kept confidential," please amend the data to be kept securely for 10 years.

3. Consider simplicity/condensing the information sheet for participants. It may be that not all of the current information provided is necessary or appropriate for participants, and a shorter sheet may be beneficial.

[redacted]

Kris Lines
Chair of the Faculty of Business Ethics Panel 9 July 2015

Appendix 13: Confirmation from my supervisor of having made acceptable ethical changes

From: VIGURS Katy E <K.Vigurs@staffs.ac.uk>
To: Hope Gangata <hopegata@yahoo.co.uk>
Sent: Wednesday, 5 August 2015, 11:07
Subject: Re: RDC1 - Hope Gangata

Thanks for sending through the amendments to your ethical forms, Hope. I am happy with the amendments you have made.

I will send the feedback on your RDC1 form by the end of this week.

Best wishes

Katy

Sent from my iPad

On 31 Jul 2015, at 15:34, "Hope Gangata" <hopegata@yahoo.co.uk> wrote:

Dear Katy

Thanks for the info on the deadlines.

I have revised the 'Consent Form' and 'Research Information Sheet for Participants' in accordance with the letter from the Ethics Committee. I have nearly halved the number of words in the 'Research Information Sheet for Participants'. Please find attached the revised forms and the original letter from the Ethics Committee.

Best wishes

Hope

Appendix 14: Frequency of the most frequently used words in transcripts

698 anatomy	40 text	28 number	21 placements	17 gap	14 past	12 previous	11 couple
368 students	40 books	28 nerve	21 order	17 focus	14 often	12 position	11 changes
290 year	39 useful	28 literature	21 modules	17 degree	14objectives	12 personal	11 certainly
215 things	39 sessions	28 great	21 model	17 days	14 nerves	12particularly	11 building
212 learning	39 person	28 gaps	21 haven	17colleagues	14 models	12 myself	11 bone
172 time	38 working	28 feel	21 draw	17 choose	14 higher	12 looked	11 arm
161 learn	38 visual	28 exams	21 depth	17 become	14 guidance	12 life	11 anterior
152 knowledge	38 still	28 exam	21 cover	16 wanted	14 graduate	12 lead	10 wrist
147 teaching	38 principles	28 encourage	21 bones	16 topic	14 exactly	12 images	10 video
140physiotherapy	38 knee	28 covered	21 big	16 times	14 definition	12 helpful	10 treat
116 teach	37 physios	28 case	20 written	16 tests	14 clinically	12 hear	10 suite
114 work	36 test	27 textbooks	20underpinning	16 tend	14classroom	12 haven't	10 sit
114 good	36 teachers	27 read	20 team	16 research	14 broad	12 fishing	10 similar
114 clinical	36 spine	27 hand	20 semester	16 realize	14 approach	12 facilities	10 setting
110 different	36 nice	27 general	20physiotherapist	16 name	14 analysis	12 Doctorate	10 revise
98 years	36 move	26 ways	20 mark	16language	13 worked	12 diploma	10 required
98 physio	36 course	26 lecture	20 joints	16 hour	13 vestibular	12 detailed	10 related
97 terms	35 textbook	26independent	20 guess	16 home	13undergraduate	12 contact	10reinforcing
84 student	35 structures	25 within	20 exercise	16guidelines	13 TV	12 common	10rehabilitation
84 muscles	35 staff	25 started	20 during	16 forget	13 thanks	12 came	10 points
80 bit	35 someone	25 specific	20 day	16 face	13 surface	12 brain	10 pages
77 book	35 medical	25 sometimes	19 term	16expected	13 small	12 becomes	10 normally
76 thing	35 many	25 skills	19somebody	16evidence	13 skeletons	12 away	10 moving
76 start	34 words	25 skeleton	19 seeing	16 engage	13 size	12 aware	10mentioned
76 something	34 teacher	25 lower	19 reading	16dissection	13 real	12 assessing	10 meet
61 taught	34 resources	25 helps	19 pathology	16 changed	13 physical	12application	10 lab
61 people	34 questions	25 best	19 obviously	16 asked	13 parts	12 across	10institution
60 problem	34 new	24 thoughts	19 normal	16 areas	13necessarily	11 tutor	10 include
58 practical	34 hip	24 study	19 hard	16 another	13 masters	11 tried	10 future
58 muscle	34 detail	24 program	19 Gray's	15 volume	13 least	11 training	10functionality
58 important	34 content	24 patients	19 drawing	15 thought	13 learned	11 total	10 formative
58 anatomical	34 body	24musculoskeletal	19conditions	15 solve	13 later	11 task	10 field
57 patient	34 area	24 interest	19 build	15 set	13 key	11 sample	10expectation
56 joint	33 UK	24 HCPC	18 weeks	15 role	13 job	11 reinforce	10 expect
55 ideas	33 school	24 class	18 top	15 Phd	13interactive	11 reasoning	10emergency
55 help	33 question	24 change	18 talking	15 neuro	13 head	11 problems	10 educators
54 outcomes	33 groups	24 applied	18 strategies	15 link	13 gave	11 plastic	10 easier
54 module	33 experience	24 anything	18 picture	15 full	13 fine	11 peer	10 context
53 remember	32 sense	23understanding	18 old	15 fit	13essentially	11 must	10 catch
53 part	32 group	23 therapy	18 methods	15educational	13 cervical	11 moment	10 care
52 level	31understand	23physiotherapists	18 keep	15curriculum	13 answer	11 mind	10 both
51 practice	31 hours	23 online	18 bring	15 check	13 already	11 means	10biomechanics
51 information	31 education	23 lectures	18 bits	15 apply	13absolutely	11 involved	10 behind
50 movement	30themselves	23 happening	18 basics	15academic	12 wrong	11 imagine	10 assume
48 thinking	30 structure	23 function	18 basically	14 works	12 write	11 growth	
48 everything	30placement	23 few	18 assess	14 view	12 visualize	11 giving	
47 university	30functional	22 relevant	18 amount	14universities	12 videos	11 generally	
46 idea	29 talk	22 profession	18 access	14 space	12 structured	11framework	
45 limb	29 stuff	22 physiology	17 towards	14 since	12 specialist	11 finding	
45 assessment	29 starting	22 ligaments	17 seen	14 short	12 sorry	11 fact	
44 session	29 example	22 feedback	17professional	14 send	12somewhere	11 explain	
43 fish	29 difficult	22 cases	17movements	14 run	12respiratory	11experiences	
41 week	29 concepts	22 basic	17 Moore	14 room	12 relate	11environment	
41 shoulder	28 upper	22 ankle	17 learnt	14 region	12reinforcement	11 elbow	
41 interesting	28 system	21 show	17individual	14 place	12 putting	11 develop	
41 CSP	28 prefer	21 possible	17 health	14 pictures	12 provide	11demonstrate	

Appendix 15: The BSc Physiotherapy modules most mentioned during the interviews

Pseudonym of University	Pseudonym of Anatomy Module	Level	Module Credits /Year Total	Pseudonym of Clinical Module	Level	Module Credits /Year Total
Post-1992-A University	Anatomy & Function Module	4	30/120	Musculoskeletal Physiotherapy	5	30/120
				Cardiorespiratory & Neurological Physiotherapy	5	30/120
				Physiotherapy Management of the Complex Patient	6	30/120
Post-1992-C University	Anatomy & Function Module	7*	30/120	Musculoskeletal Physiotherapy 1	8*	20/120
				Cardiorespiratory Physiotherapy 1	8*	30/120
				Neurological Physiotherapy	8*	30/120
				Musculoskeletal Physiotherapy 2	9*	20/120
				Physiotherapy Management of the Complex Patient	10*	20/120
19th Century University	Anatomy & Function Module	4	30/120	Musculoskeletal Physiotherapy	5	30/120
				Cardiorespiratory Physiotherapy	5	15/120
				Neurological Physiotherapy	5	15/120
				Physiotherapy Management of the Complex Patient	6	30/120
Post-1992-B University	Anatomy & Function Module	4	20/120	Cardiorespiratory Physiotherapy 1	5	10/120
	Applied Movement Science	4	20/120	Musculoskeletal Physiotherapy 1	5	20/120
				Neurological Physiotherapy	5	20/120
				Musculoskeletal Physiotherapy 2	5	20/120
				Cardiorespiratory Physiotherapy 2	5	20/120
				Physiotherapy Management of the Complex Patient	6	30/120
Plate-Glass-B University	Anatomy & Function Module 1	4	40/120	Musculoskeletal Physiotherapy	5	20/120
	Anatomy & Function Module 1	4	40/120	Neurological Physiotherapy	5	20/120
				Cardiorespiratory Physiotherapy	5	20/120
				Physiotherapy Management of the Complex Patient	6	20/120
Plate-Glass-A University	Combined Anatomy & Function, Musculoskeletal, Cardiorespiratory & Neurological Physiotherapies Module	4	Portion of 40/120	Combined Musculoskeletal, Cardiorespiratory & Neurological Physiotherapies 2a	5	25/120
	Combined Anatomy & Function,	4	Portion of	Therapies Combined Musculoskeletal,	5	25/120

	Musculoskeletal, Cardiorespiratory & Neurological Physiotherapies Module		40/120	Cardiorespiratory & Neurological Physiotherapies 2b		
				Therapies Combined Musculoskeletal, Cardiorespiratory & Neurological Physiotherapies 3	6	20/120
Russell-B University	Anatomy & Function Module	4	20/120	Musculoskeletal Physiotherapy 1	4	20/120
				Cardiorespiratory Physiotherapy	5	20/120
				Musculoskeletal Physiotherapy 2	5	10/120
				Neurological Physiotherapy	5	20/120
				Physiotherapy Management of the Complex Patient	6	20/120
Russell-A University	Anatomy & Function Module 1	4	20/120	Musculoskeletal Physiotherapy 1	4	20/120
	Anatomy & Function Module 2	4	20/120	Cardiorespiratory Physiotherapy 1	5	10/120
	Module with Minor Anatomy Element	4	10/120	Musculoskeletal Physiotherapy 2	5	20/120
	Module with Minor Anatomy Element	4	15/120	Cardiorespiratory Physiotherapy 2	6	10/120
				Neurological Physiotherapy	6	15/120
				Musculoskeletal Physiotherapy 3	6	10/120
				Physiotherapy Management of the Complex Patient	*5*	*??*
				Optional modules • 1 x Cardiorespiratory Physiotherapy subspecialties • 5 x Musculoskeletal Physiotherapy Subspecialties • 5 x Neurological Physiotherapy subspecialties	6	10/120 each

Year 1,2 and 3 were taught at the level 4,5 and 6 of the FHEQ (Quality-Assurance-Agency-for-Higher-Education, 2008) respectively, except for Post-1992-C University which was a four year course and knowledge was taught at levels 7, 8, 9 and 10 of the Scottish Credit and Qualification Framework. Each year across the eight universities had a total of 120 credits.

Appendix 16: Anatomy books with Visual Anatomical Imagery mentioned by six anatomy teachers

Teacher	Anatomy Book
Samuel	**Porter, S. (2008). The anatomy colouring and workbook. Elsevier Health Sciences.**
Kelly	Field, D., & Hutchinson, J. S. O. (2006). Field's anatomy, palpation, and surface markings. Elsevier Health Sciences. ***Drake, R., Vogl, A. W., & Mitchell, A. W. (2014). Gray's anatomy for students. Elsevier Health Sciences.** *Moore, K. L., Dalley, A. F., & Agur, A. M. (2013). Clinically oriented anatomy. Lippincott Williams & Wilkins. **Cael, C. (2011). Functional anatomy: Musculoskeletal anatomy, kinesiology, and palpation for manual therapists. Lippincott Williams and Wilkins.** Gosling, J. A., Harris, P. F., Humpherson, J. R., Whitmore, I., & Willan, P. L. (2008). Human anatomy, color atlas and textbook. Elsevier Health Sciences.
Keith	Palastanga, N., Field, D., & Soames, R. (2006). Anatomy and human movement: structure and function (Vol. 20056). Elsevier Health Sciences. **Netter, F. H. (2010). Atlas of human anatomy. Elsevier Health Sciences.** **Moore, K. L., Dalley, A. F., & Agur, A. M. (2013). Clinically oriented anatomy. Lippincott Williams & Wilkins.**
Nathan	Palastanga, N., Field, D., & Soames, R. (2006). Anatomy and human movement: structure and function (Vol. 20056). Elsevier Health Sciences. Drake, R., Vogl, A. W., & Mitchell, A. W. (2014). Gray's anatomy for students. Elsevier Health Sciences.
Vanessa	***Neumann, D. A. (2013). Kinesiology of the musculoskeletal system: foundations for rehabilitation. Elsevier Health Sciences.** Drake, R., Vogl, A. W., & Mitchell, A. W. (2014). Gray's anatomy for students. Elsevier Health Sciences. *Palastanga, N., Field, D., & Soames, R. (2006). Anatomy and human movement: structure and function (Vol. 20056). Elsevier Health Sciences.
Claire	**Neumann, D. A. (2013). Kinesiology of the musculoskeletal system: foundations for rehabilitation. Elsevier Health Sciences.**

**Anatomy books that had useful clinical knowledge*

Appendix 17: General anatomical principles for physiotherapy students

Learning objectives	Organisational Principles	Functional and Clinical Principles
Terms	Terms of: position, relationship, comparison, movement	
	Principle of how the names of anatomical structures are named sensibly	
Organs	Bone structure and bone marrow	Roles (mechanical and haemopoietic)
Somatic structures:	Bony features	Growth of bones
	Cartilage	Blood supply of a long bone
	Parts of a developing long bone	Fractures and epiphyseal injuries
	Growth plate and epiphyseal line	
	Joint types (fibrous, cartilaginous and synovial)	Trade-off between mobility and stability
		How muscles act as stabiliser or mobilisers
	Articular surfaces and articular cartilage	Joint degeneration
	Synovial cavity and synovial membrane	Roles of synovial membrane and fluid
	Fibrous capsule, ligaments and special structures	Dislocations and ligament injuries
	Muscle structure and attachments	Types of muscle contraction and actions
	Key principles on muscular systems	How muscles function in everyday use
		How gravity affects muscle use
	Tendons and aponeuroses	Muscle and tendon injuries
	Fascial septa, sheets and sheaths	Roles and regional adaptations of fascia
	Neurovascular hilum	Motor point, muscle units and muscle tone
	Myotomes	
	Skin structure, appendages and specialisations	Roles of skin
	Cutaneous nerve supply	Relaxed skin tension lines
	Dermatomes	Nerve overlap and internervous lines
	Axial borders and lines	Referred pain and sites of referral
Supply structures:	Somatic and visceral nerve fibre types	Sensory and motor functions
	Spinal cord segments	Sympathetic and parasympathetic roles
	Spinal nerves, roots and rami	Reflexes and components of a reflex arc
	Plexuses and peripheral nerves	Segmental and peripheral nerve supply
	Nerve branches and distribution	Reflex muscle spasm
Body regions	Head and neck, trunk, Upper and lower limbs	Midline: Coronal morphological plane
	Paired and unpaired regions: Flexor and extensor regions	Compartment syndrome
	Compartments and layers	Potential paths of direct spread
	Mobile and fixed fascial planes	Hernia
	Body walls and parietal structures	Prolapse
	Serous sacs with body cavities	Neurovascular endangerment.
	Neurovascular bundles and pathways	
Range of normality	Normal variation	Constitutional and functional factors
	Anatomical variation	Surgical and radiological implications
	Pathological changes (congenital and acquired)	
(grey)	Means that the anatomical principles were copied from the paper by Louw et al., 2009	
(blue)	Means the anatomical principle was both mentioned in the paper by Louw et al., 2009, and by at least an anatomy teacher in the current study	
(orange)	Means the anatomical principle was only described by at least an anatomy teacher in the current study and NOT mentioned in the paper by Louw et al., 2009.	

Appendix 18: The contribution of my prior expectations and five major pedagogical concepts towards the CSP Physiotherapy Framework sub-domains

Domains of the CSP Physiotherapy Framework	Sub-domains of the CSP Physiotherapy Framework	The contributions of anatomical education & training to the physiotherapy sub-domains, based on my prior expectations	The contribution of the five major pedagogical concepts from the study to the physiotherapy sub-domains
Physiotherapy values	The values at the heart of physiotherapy practice are: Altruism; Advocacy; Honesty & integrity; Compassion & caring; Accountability for decision making & actions; Fulfilment of duty of care & social responsibility; Commitment to excellence.		
Knowledge & understanding of physiotherapy	Knowledge & understanding that is relevant to the individual's context of practice & their individual scope of practice The core knowledge of physiotherapy for entry-level practice includes: • the structure & function of the human body; • health, disease, disorder & dysfunction; • the principles & applications of scientific enquiry; • the role of other professions in health & social care; • the biomedical, behavioural, physical & social science bases of physiotherapy & how they inform practice; • the theories underpinning the approaches used in physiotherapy practice; • the ethical principles underpinning physiotherapy practice; • the legal & policy frameworks governing physiotherapy	• Anatomical knowledge of the human body • Knowing when to apply anatomical knowledge and practical anatomical skills to clinical physiotherapy situations	• The use of Visual Anatomical Imagery • Strategies for teaching the clinical application of anatomy i. Fidelity principle of the CLT & 4CID theories ii. Variability principle of the CLT & 4CID theories iii. Completion strategy of the CLT & 4CID theories

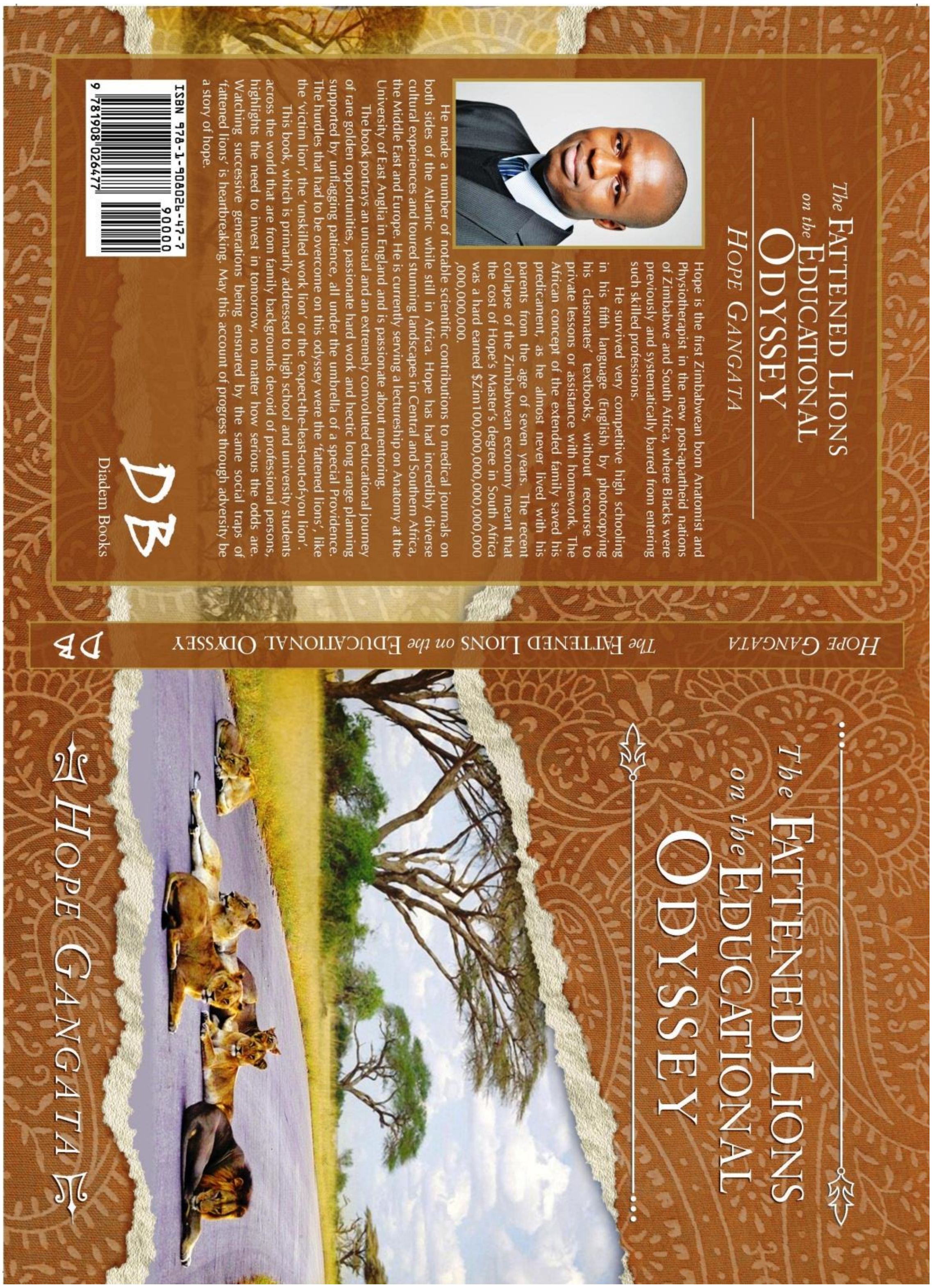
	Political awareness Knowledge & understanding of the political, social, economic & institutional factors shaping the health & wellbeing economy & how they inform the design/delivery of physiotherapy		
	Self-awareness A conscious knowledge & understanding of one's self which is developed through reflective practice The core knowledge of physiotherapy for entry-level practice includes:		
Physiotherapy practice skills	**Profession-specific practice skills** These are the (psycho-motor) skills that relate to physiotherapy's scope of practice & primary aim of maximising individuals' movement potential, e.g. manual therapy, exercise, electrotherapeutic modalities and injection therapy **Generic practical & technical skills:** These practical & technical skills are shared with other workers in health, social care & education e.g. First Aid, Manual handling.	Practical anatomical skills such as palpation	The use of Kinaesthetic Anatomical Skills
Generic behaviours, knowledge and skills i. Behaviours, Knowledge & Skills For Interacting	**Communicating** The interactive process of constructing & sharing information, ideas & meaning through the use of a common system of symbols, signs & behaviours.	Being able to communicate with formal anatomical terminology	
	Helping others learn & develop The process of working with individuals and/or groups to create activities & opportunities to promote learning & development.		

	Managing self & others The process of planning, prioritising, organising, directing/facilitating action & evaluating performance. This process may involve the organisation of financial, human, physical & technological resources.		Using anatomical principles for metacognition (metacognition schema for generic benchmarking and functional predicting)
	Promoting integration & teamwork The process of working with others to achieve shared goals.	The domain will be applicable if students learn in groups or teams	
	Putting the person at the centre of practice The process of developing an understanding of an individual & their lived experience, & using that understanding to tailor practice to the needs of that person		
	Respecting & promoting diversity The process of recognising, respecting & valuing people's differences (e.g. age, disability, gender, race, religion & belief, sexuality) & applying this to daily work & decision making		
ii. Behaviours, knowledge and skills for problem-solving and decision making	**Ensuring quality** The process of maintaining the effectiveness, efficiency & quality of a service provided.		
	Improving & developing services The process of improving the effectiveness, efficiency & quality of the service provided.		

	Lifelong learning The process of learning & development directed towards maintenance & enhancement of professional competence	Students and graduates will need to be continually updating and improving their anatomical knowledge and skills	Spiral curriculum strategies i. Sequencing principle of the CLT & 4CID theories ii. Fading principle of the CLT & 4CID theories iii. Repetition and reinforcement to minimise the decaying of temporary knowledge
	Practice decision making The context-dependent thinking & decision making processes used in professional practice to guide practice actions		
	Researching & evaluating practice Systematic processes of collecting, analysing, & synthesising information to evaluate current practice & generate new understandings about practice		
	Using evidence to lead practice The process of analysing, synthesising & evaluating the best-available evidence, & integrating it with individual expertise & service users' needs & preferences to inform practice		

Appendix 19: My Autobiography book cover

Below is the book cover of the autobiographical book of the author aimed at raising aspirations of children from disadvantaged families.



Appendix 20: Shortlisted for Outstanding Teacher of the Year Award (University of Birmingham)

UNIVERSITY OF BIRMINGHAM
Your Students' Union
University of Birmingham guild of students

OUTSTANDING TEACHING AWARD

Outstanding Teaching Award 2015

PERSONAL

Dr Hope Gangata
Anatomy
Medical School

Tuesday 19 May 2015

Dear Dr Gangata,

We are delighted to let you know that you have been shortlisted for the College of Medical and Dental Sciences, Outstanding Teaching Award.

The Outstanding Teaching Awards are a joint venture between the University and the Guild of Students designed to recognise one member of teaching staff from each of the University's five Colleges who demonstrates truly excellent teaching. Over 390 nominations were received from the student body, and a panel of judges will now review the nominations to select the winners.

The Outstanding Teaching Awards recognise members of staff who have encouraged and facilitated active learning and provided teaching that is stimulating, enthusiastic, innovative and consistently challenging. We would like to add our personal congratulations in support of your nomination from the students who place such a high value on your teaching.

The full list of nominations and shortlisted candidates will be sent to Heads of College, and the winners will receive a letter from the Vice Chancellor and President of the Guild. The awards will be presented by the Vice Chancellor and President of the Guild of Students at the July Degree Congregations.

With best wishes

[redacted]

Professor Jeff Bale, Pro-Vice-Chancellor
Joe Armer, Vice-President (Education), Guild of Students

Appendix 21: Nomination for Outstanding Teaching Awards (University of Birmingham)

From: Student Reps [mailto:studentreps@guild.bham.ac.uk]
Sent: 07 April 2017 08:31
Cc: Student Reps
Subject: Outstanding Teaching Awards

Good morning,

The University and the Guild of Students Outstanding Teaching Awards nominations for this year have now closed and I am delighted to let you know that you have been nominated.

Shortlisting will be taking place throughout April, the winners are to be decided in May and awards are presented in Degree Congregations.

The awards are designed to recognise one member of teaching staff from each of the University's five colleges that demonstrates truly excellent teaching. Those nominated have encouraged and facilitated active learning and provided teaching that is stimulating, enthusiastic, innovative and consistently challenging. They have expertise in their field and are committed to sharing their knowledge with their students.

The Vice-Chancellor, Professor Sir David Eastwood, said: "*The University has a strong commitment to enhancing teaching and learning; to support this we are rewarding those that enhance the experience of student learning through excellence in teaching. The Outstanding Teaching Awards celebrate talented teachers that demonstrate best practice and foster the learning and development of our students.*"

Chris Wilkinson, Education Officer at the Guild of Students, said: "*We all have been fortunate to have a truly incredible teacher; someone who is passionate about teaching and pulls out all of the stops to make sure you are supported. The Outstanding Teaching Awards is the perfect opportunity to recognise truly incredible staff that inspire you, and thank them for all of their hard work. I would strongly encourage all students to nominate that one lecturer that has made an incredible difference to their education.*"

If you would like to know some of the comments from within your nomination/s please let us know and we can share this with you (this will be in around 2 weeks once all shortlisting panels have met).

Best wishes, and congratulations on being nominated,

Student Reps Team

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University of Birmingham Guild of Students
Tel: 0121 251 2300 (main switchboard)
Email: studentreps@guild.bham.ac.uk
Website: www.guildofstudents.com

Appendix 22: Offer letter to present the current EdD abstract at the upcoming annual CSP conference

From: physiotherapyuk2017@abstractserver.com
[mailto:physiotherapyuk2017@abstractserver.com]
Sent: 06 July 2017 13:52
To: hopegata@yahoo.co.uk
Subject: Physiotherapy UK 2017 - Rapid 5 Offering Notification A-916-0001-00311

Dear Hope Gangata,

Thank you for submitting an abstract for review for Physiotherapy UK 2017.

Reference Number: A-916-0001-00311
Title: An analysis of pedagogical concepts used by anatomy teachers to facilitate the teaching and learning of anatomy to physiotherapy undergraduates
Congress Theme: Evidence Matters - Qualitative

I am delighted to inform you that this abstract has been selected for this year's event. We understand that you had originally asked for a different presentation method however the review panel were very impressed with your abstract and therefore would like to offer you the opportunity to present it as a **RAPID 5 SESSION**.

A Rapid 5 is a platform presentation session of abstracts each delivering key messages from the research or development using no more than five slides in five minutes; followed by 10 minutes open poster viewing including discussion of the findings, interpretation and application in practice between delegates and presenters at points around the room, and a further 10 minutes of moderated discussion, drawing all presenters and delegates back together.

Please note that for a rapid 5 session you will be required to prepare both a **presentation and a poster.**
We have attached some Platform and Rapid 5 Preparation and Presentation Guidance, as well as poster guidelines, which you should to refer to.

I would be grateful if you could confirm your acceptance (presenting author *Hope Gangata*), withdraw or change the presenter by **17 July 2017**. If we do not hear from you by this date, we assume you are not available to present your poster at Physiotherapy UK 2017.

To confirm, please click on the web-link below and follow the instructions given:

http://www.abstractserver.com/physiotherapyuk2017/confirm/

You should now book your place, which you may do at the special rate of £262. This early bird offer expires on 19 July, so please be sure to book soon, as the normal price is £309. When you book simply select the 'Platform or poster presenter' option on the registration form online: http://www.physiotherapyuk.org.uk/#booknow.

If you submitted more than one abstract, you will receive an email outlining the review panel's decision for each one.

If you have any questions about Physiotherapy UK 2017 please contact physiotherapyuk@csp.org.uk.

Please note the current programme shown online is subject to change.

We are pleased to announce that all service evaluation abstracts will be automatically submitted in to the CSP Case Studies database to promote the benefits and successes of physiotherapy. If you do not give your consent to release copyright to the CSP to develop and publish the abstract in case study format, please email casestudies@csp.org.uk to opt out. You will be contacted for further information and final approval before this is published using your abstract contact details. For more information, please visit http://www.csp.org.uk/casestudies

We look forward to seeing you in Birmingham in November. Congratulations once again on your successful submission to Physiotherapy UK 2017.

Yours sincerely,

Dr Gillian Yeowell, (Chair), Dr Stephanie Best, Professor John Dixon, Dr Vicki Goodwin MBE

Physiotherapy UK Abstract Review Group

Appendix 23: Confirmation for presenting the current EdD abstract at the upcoming annual CSP conference

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From: Physiotherapy UK 2017 <physiotherapyuk2017@abstractserver.com>
To: Hope Gangata <hopegata@yahoo.co.uk>;
Sent: Monday, 17 July 2017, 21:59
Subject: PHYSIOTHERAPY UK 2017 - Your Abstract Confirmation

Dear Hope Gangata,

Thank you for confirming your abstract entitled [**An analysis of pedagogical concepts used by anatomy teachers to facilitate the teaching and learning of anatomy to physiotherapy undergraduates**] to the Physiotherapy UK 2017 taking place at the International Convention Centre, Birmingham on 10-11 November 2017.

Abstract reference number: **A-916-0001-00311**
Presenter: **Hope Gangata**, hopegata@yahoo.co.uk

We have noted that your abstract will be presented at the Physiotherapy UK 2017 in Birmingham.

Thank you again for your contribution.

Best regards,

The PHYSIOTHERAPY UK 2017 Abstract Team

If you have any questions, please contact: physiotherapyuk2017@abstractserver.com

Appendix 24: Confirmation of being granted Senior Fellowship by the Higher Education Academy

UNIVERSITY OF BIRMINGHAM

Centre for Learning and Academic Development & Learning Spaces

Beacon professional recognition scheme

Return of Beacon results to Applicants

Dear Hope,

I am delighted to inform you that following the Beacon Panel that met on 23 June 2017, you have been awarded Senior Fellow of the Higher Education Academy. A formal letter will also be sent to your Head of School notifying them of your success.

Please find attached your feedback. As well as your feedback, I have also included two other documents. The first document is a form for you to complete in order for us to register your details with the HEA as well as asking for permission to use your application as a resource for future applicants through the scheme. Please complete and return this to David Santoro (d.santoro@bham.ac.uk). The second document is a Programme Evaluation Form which we will use to shape the programme in the future. Please complete and return this to beacon@contacts.bham.ac.uk.

Finally we are keen to stay in touch with all of our Beacon applicants. One way to achieve this is to offer you the opportunity to give back to the scheme through mentoring and becoming an assessor for future applicants. We have applications coming in for September 2017 and beyond and would be delighted if you were willing to contribute in this way. Please let me know if this is something that interests you and I can send you further details.

I wish you all the best for your future engagement with teaching matters at Birmingham and elsewhere.

Best wishes.

[redacted]

Sarah King
Sarah King, PFHEA
Programme Director, PgCert Higher Education / PgCert Academic Practice
Programme Lead, Beacon (Professional Recognition Scheme)

Centre for Learning and Academic Development & Learning Spaces
Watson Building
University of Birmingham
Birmingham B15 2TT
Tel: 0121 414 2963

Appendix 25: Search terms used for the literature review in Module 5

List-A to List-D shows the search terms typed into the Google-Scholar website (Google-Scholar, 2017) and Pubmed website (Pubmed, 2017) search websites to find the initial literature.

List-A	List-B	List-C	List-D
Physiotherapy/physical therapy anatomy plus words below	**Physiotherapy/physical therapist** plus words below	**Anatomy** plus words below	**Other**
curricula	curricula	pedagogy	designing anatomy curricula
teaching	teaching	teaching	desirable anatomy curricula
learning	learning	learning	
history	history	curricula	
content	pedagogy	assessments	
textbooks	competency	multiple choice questions	
society	proficiency	extended matching questions	
clinical	assessment	computer based	
pedagogy	definition	time	
constructivism	time	hours	
	computer	traditional pedagogy	
	epistemology	epistemology	
	Health Care Professions Council	content	
	Health Care Professions Council anatomy	designing course	
	professional board anatomy	society anatomy	
	future	cadaver	
	developing countries	constructivism	
	specialisation	practical	
	most common conditions	clinical	

Appendix 26: List of available anatomy textbooks for physiotherapy in Module 5

The appendix shows the results of a search of anatomy textbooks on Amazon Company in the UK (Amazon-UK, 2014) using the words “anatomy” and “physiotherapy/physical therapy” or “physiotherapist/physical therapist” revealed the following twelve books.

	Book Title	Reference
i.	Functional movement in orthopaedic and sports physical therapy: evaluation, treatment, and outcomes.	(Brownstein & Bronner, 1997)
ii.	Functional anatomy: musculoskeletal anatomy, kinesiology, and palpation for manual therapists.	(Cael, 2010)
iii.	Hollinshead's functional anatomy of the limbs and back.	(E. W. Jenkins, 2000)
iv.	Muscles, testing and function: with posture and pain.	(Kendall, McCreary, & Provance, 1993)
v.	Brunnstrom's clinical kinesiology.	(L. K. Smith, Weiss, & Lehmkuhl, 1996)
vi.	Clinical kinesiology and anatomy.	(Lippert, 2011)
vii.	Kinesiology: scientific basis of human motion. Madison, WI: Brown & Benchmark.	(Luttgens, Hamilton, & Deutsch, 1997)
viii.	Functional anatomy of the spine.	(Middleditch & Oliver, 2005)
ix.	Anatomy and physiology for physiotherapists.	(Moffat & Mottram, 1979)
x.	Anatomy and human movement: structure and function.	(Palastanga et al., 2000)
xi.	Anatomy and physiology for physiotherapists.	(Singh, 2006)
xii.	Kinesiology: application to pathological motion.	(Soderberg, 1997)

Appendix 27: The total contact hours for teaching gross anatomy for medical students

The contact hours for medical students was considered because the total number of contact hours available for gross anatomy for physiotherapy were not available in literature.

Year Assessed	Average Total of hours taught	Number of medical schools assessed	Country or region	Notes	Reference
1902	549	Not mentioned	USA		(Numbers, 1980) cited in (Dyer & Thorndike, 2000)
1909	800	Most of the respected medical schools in USA	USA	Included histology, embryology and neuroanatomy	(Bardeen, 1909)
1931	780	47	USA	Included histology, embryology and neuroanatomy	(Reid, 1931)
1939	338	Not mentioned	USA		(Weiskotten et al., 1940) cited in (Eldred & Eldred, 1961)
1955	330	Not mentioned	USA		(Jackson, 1956) cited in (Eldred & Eldred, 1961)
1966	290	Not mentioned	USA		(Educational Affairs Committee., 1966) cited in (Blevins & Cahill, 1973)
1971	197	77	USA and Canada		(Blevins & Cahill, 1973)
1991	182	Not mentioned	USA and Canada		(Collins & Given, 1994) cited in (Cottam, 1999)
1991	192	33	Great Britain and Ireland		(Fitzgerald, 1992)
1991	190	102	USA		(Cottam, 1999)
1997	165	102	USA		(Cottam, 1999)
2000	160	21	Great Britain and Ireland	For schools with traditional pedagogy/Median	(Heylings, 2002)
2000	50	1	Harvard University		(Dyer & Thorndike, 2000)
2007	198	13	Africa	The total hours is the median	(Kramer, Pather, & Ihunwo, 2008)
2012	56	1	University of East Anglia		The author taught at this university 2009-2013

Appendix 28: Proposed Research Design, Methodology and Methods (Second Time of Reviewing Literature)

EdD Module: Educational Research: Philosophy and Practice Assignment

By Hope Gangata

BSc Hons Physiotherapy, BSc Hons Intercalated Hum Anatomy, MSc Medicine in Anatomy, M.A. Higher Education Practice (UK), Fellow of the UK Higher Education Academy, Registered UK Physiotherapist & Part-time EdD Candidate

A research approach for a proposed study entitled:

'The proposed theory based on key concepts involved in running an effective and modern anatomy curricula for physiotherapy practice'

Abstract

200 words

The assignment is presenting a research design for a proposed research thesis for my EdD Research Inquiry module entitled "The proposed theory based on key concepts involved in running an effective and modern anatomy curricula for physiotherapy practice". Physiotherapy is a young profession which has experienced a huge growth in the last 30 years in terms of the number of physiotherapists, schools of physiotherapy and knowledge base of physiotherapy. However, the teaching of anatomy for physiotherapy is in the doldrums. The anatomy curricula for physiotherapy is taught in a old fashioned manner, lacks a recommended textbook and lacks explicit theory to guide pedagogic activity. The assignment argues that the ontology (the nature of things) is conceptual in the form of 'key concepts', radical constructivism as the epistemology (how we know what we know) and a constructivistic form of grounded theory for methodology are the most appropriate for the research design. Radical constructivism advocates for knowledge created in individual minds as a result of extensive individual cognition and the knowledge created is very subjective and individualistic. The proposed research practical implications (methods) are critically examined and explored. The assignment ends with critically examining the strengths and limitations of the assignment.

Table of Contents

1 Introduction and rational of the assignment

1.1 Introduction

The current assignment would like to address the design concerns of a proposed research, in terms justifications, strengths and limitations, that I will carry out for my Research Inquiry as part-fulfilment for the Doctorate in Education degree. The Research Inquiry will explore pedagogical issues of the anatomy curricula for physiotherapists with a view of developing a theory explaining how to run a highly effective and modern anatomy curricula for physiotherapy. In this introduction section, I will explain the context of the proposed research, the curricula problem, the anticipated research outcome, the importance of the research and a summary of the how the rest of the assignment will be structured.

1.2 Research problem

1.2.1 The context of research

Physiotherapy has experienced a rapid growth since the 1970s, in terms of the volume of physiotherapy knowledge (Crosbie et al. 2002; Krause et al. 2006), new areas of specialisation in physiotherapy (Latman and Lanier, 2001), increased demand for physiotherapists, increased numbers of qualified physiotherapists and increased number of Schools of Physiotherapy (Latman and Lanier, 2001; McMeeken, 2008). For example, the number of physiotherapy schools in USA almost doubled between 1994-2012 (Reimer et al. 2013). Possessing the knowledge of anatomy is an integral requirement for practising good physiotherapy (Mattingly and Barnes, 1994; Latman and Lanier, 2001; McCuskey et al. 2005; McMeeken, 2008). Physiotherapists are especially strong in musculoskeletal anatomy (Mattingly and Barnes, 1994; Kawashiro et al. 2009; Nicholls and Gibson, 2010) as evidenced by physiotherapy students having better musculoskeletal anatomical knowledge than medical students (Valenza et al. 2012).

However, the developments in the anatomy teaching for physiotherapists have been depressing. The teaching of anatomy for physiotherapy is dominated by the traditional teacher-centred pedagogy of using lectures and cadaveric dissections that dominated the 1950s to 1980s (Latman and Lanier, 2001; Reimer et al. 2013). There is a relative dearth of literature from the last couple of decades on giving recommendations on how the anatomy curricula for physiotherapy should be more effectively structured, delivered and assessed, when compared to the anatomy curricula for medical students (Latman and Lanier, 2001). The content of anatomical knowledge for physiotherapy is due for upgrade because certain fields of general physiotherapy have now blossomed into new specialties of physiotherapy, such as cardio-pulmonary physiotherapy and obstetrics/gynaecology physiotherapy (Mattingly and Barnes, 1994). The lack of guidelines for an anatomy curricula for physiotherapy has made the writing of an anatomy textbook for physiotherapy an uphill task. Physiotherapy students are sadly being made instead to learn anatomy from anatomy textbooks meant for medical students or from texts made in-house by their anatomy teacher because there is no single published anatomy textbook with physiotherapy clinical relevance (Mattingly and Barnes, 1994). Based on calculations of how much formal curricula time is available for training physiotherapists on anatomy (Crosbie et al. 2002), the upper limit is probably about 100 contact hours to teach the full anatomy curricula for physiotherapy.

1.2.2 <u>The curricula problem</u>

Literature on the anatomy curricula for physiotherapy, in my view, is broadly split into two categories: surveys aimed at gathering anatomy teaching practices and comparing the advantage of using one teaching resource over another.

Surveys aimed at gathering anatomy teaching practices (Latman and Lanier, 2001; Mattingly and Barnes, 1994; Abdur-Rahman, 2007; Prados et al. 2007; Reimer et al. 2013) reveal a dominance of the traditional way of teaching anatomy (Latman and Lanier, 2001), such as the use of anatomy lectures and dissection of cadavers during an earlier phase of professional training (Flexner, 1910). About a third of physiotherapy degree programs are taught anatomy in a class with other degree programs (Mattingly and Barnes, 1994; Latman and Lanier, 2001) hamstringing the teaching of the physiotherapy clinical relevance. Anatomy courses are either run by anatomy departments or physiotherapy departments (Latman and Lanier, 2001) because the course requires joint anatomy and physiotherapy expertise, which is hard to come by on an individual. These surveys simply encourage the entrenchment of the “status quo” (Latman and Lanier, 2001 p.156) and are handicapped to new ways of thinking.

Comparing the advantage of using one teaching resource over another may not be conclusive because each teaching resource has literature to support or criticize it (Latman and Lanier, 2001). Various physical resources have been advocated to assist the learning of anatomy by physiotherapy students, such as computer-based resources (Lee and Allison, 1992; Bacro, 2002; Mitchell et al. 2004; Foreman et al. 2005; Thomas et al. 2011; Veneri, 2011), case-based resources (Parmar and Rathinam, 2011), textbooks (Bukowski et al. 1980) and audience response systems (Wait et al. 2009). Human resources have been vouched for, such as using teamwork (Ghorbani et al. 2014), peer-to-peer teaching (Youdas et al. 2008), a multiprofessional context (Mitchell et al. 2004), oral examinations (Fabrizio, 2013) and individual feedback (Youdas et al. 2013). A given set of selected teaching resources create ‘patchwork pedagogy’ whereby teaching resources have no cohesion with each other and in regards to overall teaching, learning, teacher-student interaction and assessment. The literature on surveys and competing teaching resources has failed to fill the void of pedagogic theory required for the overall guidance of running anatomy courses for physiotherapy. Pedagogic theory should lead the direction of the anatomy curricula for physiotherapists, in terms of planning, learning objectives, teacher-student interaction and assessment, rather than allowing historical ‘status quo’ or teaching resources dictate the way of teaching anatomy.

1.2.3 What the proposed research hopes to find out

The proposed study hopes to find the ‘key concepts’ involved ‘in running an effective and modern anatomy curricula for physiotherapy’. Concepts will be taken to mean teaching and learning understandings by anatomy teachers that they highly cherish and actively use to promote ‘effective’ teaching and learning practices that help students to learn anatomy for their future physiotherapy professional career. These ‘concepts’ are located and have been constructed in the minds (first layer of construction) of anatomy teachers and are the individual understandings of phenomenon found in their teaching experiential world. The constructed knowledge of ‘key concepts’ will require the researcher interacting with the minds of anatomy teachers, by means of interviews, to produce a second layer of constructed knowledge that will be analysed using a constructivist version of grounded theory. The second layer of construction in the mind of the researcher occurs because knowledge cannot be transferred from one person to another in constructivism (Von Glasersfeld, 1990). Grounded theory will convert the underlying ‘concepts’ found in the second layer of constructed knowledge into a theory. ‘An effective curricula’ will be taken to mean an anatomy curricula that generates anatomical knowledge among students actively that is useful and enduring to the students, and an anatomy curricula that students find relevant for their future individual clinical physiotherapy experiences. An ineffective curricula will not encourage students to create knowledge in their minds, promotes passive learning and will poorly prepare physiotherapy students with inadequate anatomical knowledge for their future clinical physiotherapy career.

1.2.4 The importance of the research

The research is important because it will provide guidance to the anatomy curricula for physiotherapy on how it can be most effectively structured, delivered and assessed. The research outcome will guide anatomy teachers, course leaders and students, on how to most effectively run anatomy courses for physiotherapy. The research outcome will also guide how teaching resources can be aligned in terms of: faculty staff, teaching and learning resources, time allocation and research resources. Research outcome on how to teach anatomy to physiotherapy students will provide assistance to future authors, who will write anatomy textbooks for physiotherapists. The wisdom of how to most effectively run the anatomy curricula might inspire other disciplines in the health sector with poorly crafted anatomy curricula based on historical primacy, such as occupational therapy, speech therapy, radiography and podiatry (Latman and Lanier, 2001) to generate appropriate anatomical pedagogic theory

1.3 Purpose of this assignment

The assignment will synthesis a research design to plan for a proposed research to create a theory on how an anatomy curricula for physiotherapy can be run most effectively. The assignment will start by explaining why a certain research approach was chosen, then proceed to describe how the research approach will influence the practical running of the research and will lastly critically evaluate the strengths and limitations of the assignment.

2 The research approach for my study

The following major element of the assignment will be examining the research approach that will be used for the EdD Research Enquiry and I will start by defining terms that will be used in the rest of the assignment, followed by discussions on the ontology, epistemology, methodology and lastly the practical methods.

2.1 Working definitions of terms

It is a common tradition in philosophical papers that terms are not similarly defined and I will start by defining my working definitions that will be used in the rest of this assignment.

2.1.1 Ontology

It is important to determine what type of ontological view my research will be seeking because it will directly influence the epistemology, methodology and ultimately the research methods. For my current assignment, I will use this definition of ontology as the study and philosophy of “the nature of reality and the nature of things” (Hitchcock and Hughes, 1995 p.21). Scholars differ on their views of the categories of the nature of reality and that gives rise to a number of definitions for ontology.

Some scholars had ontological views that only tangible things that people could sense or handle were real, but in the last century, ontological views have emerged that include thoughts and ideas too (Cohen et al. 2007). Although there are many views on what is the nature of reality, such as materialism (everything can be reduced to matter), dualism and idealism, amongst other ontological theories (Cardinal et al. 2004), the current assignment will adopt the dualism theory of ontology by Burrel and Morgan (1979) of nominalism and realism. Realism declares that there is a real tangible world outside our cognition, while nominalism says that the outside world is merely made up of names and labels that we artificially make in our minds (Burrel and Morgan, 1979; Cohen et al. 2007).

The ontological view of my Research Inquiry of my EdD would be that ‘key concepts’ squarely falls into the nominal category of the dualism theory of Burrel and Morgan (1979). The nature of reality being sought by the proposed study will be ‘concepts’ that are the individual understanding of the actual phenomenons that anatomy teachers encourage and intentionally promote in their teaching practice in order to help students individually learn anatomy for their future physiotherapy professional career. Thus the nature of reality is the nominal understanding of the effective teaching phenomenon and not the teaching phenomenon itself. The section with a subheading of ‘Choice of epistemological stance’ on page 11 will describe how I will come to know of the ‘concepts’ from my research subjects. The section with a subheading of ‘Choice of methodological stance’ page 19 will describe how I will convert the ‘concepts’ into a theory involved in running an effective anatomy curricula using grounded theory.

The next section will examine how we can know of these ‘key concepts’.

2.1.2 Epistemology

How we can know of the nature of reality of the ‘key concepts anatomy curricula for physiotherapy practice’ falls underneath the epistemology umbrella.

The word epistemology, comes from the Greek words the ‘logos’ (the study of) and ‘episteme’ (knowledge or understanding), governs “how you know what you know” (Feder, 2013). Epistemology is highly philosophical because each major branch of epistemology has a set of assumptions and beliefs it holds dear in order to define precisely what it terms knowledge and most definitions are incompatible with each other. It is healthy to have multiple versions of epistemologies in order to address a growing and complex body of knowledge (Feyerabend 1975, cited by Geelan, 1997). Epistemology challenges the sources of our knowledge by creating validity thresholds for those sources (Scott and Usher, 1999; Hitchcock and Hughes, 1995) and are the lens through which we see knowledge. Epistemology in research pertains to being able to predict the form and type of knowledge to be gained from a research and how that knowledge is to be generated. Epistemology has a significant bearing on the research, such as on how the title of the research is to be worded, choice of subjects and how the research is going to be practically designed (Hitchcock and Hughes, 1995; Hesse-Biber and Leavy, 2006).

2.1.3 Methodology and Methods

Methodology will be defined in this assignment as “a research strategy that translates ontological and epistemological principles into guidelines that show how research is to be conducted” (Sarantakos, 2005 p.30) and the methodology connects the epistemological theory to the practical methods (Hesse-Biber and Leavy, 2006). The method will be defined as the practical “techniques for gathering evidence” (Harding 1997 p.2, cited by Carter and Little, 2007). It is common for the methodology and method terms to be incorrectly used, sometimes interchangeably, in research papers, especially in scientific fields (Gorman, 2011; Politicseastasia, 2014)

There are many routes of examining the ontological, epistemological, methodological issues and methods of a planned research. One approach is to examine these themes simultaneously from a research paradigm level. The notion of research paradigms frequently appear in epistemological discussions and describe how a type of ontology, epistemology, methodology and methods are linked together as shown in Figure 1 below from Sarantakos, 2005.

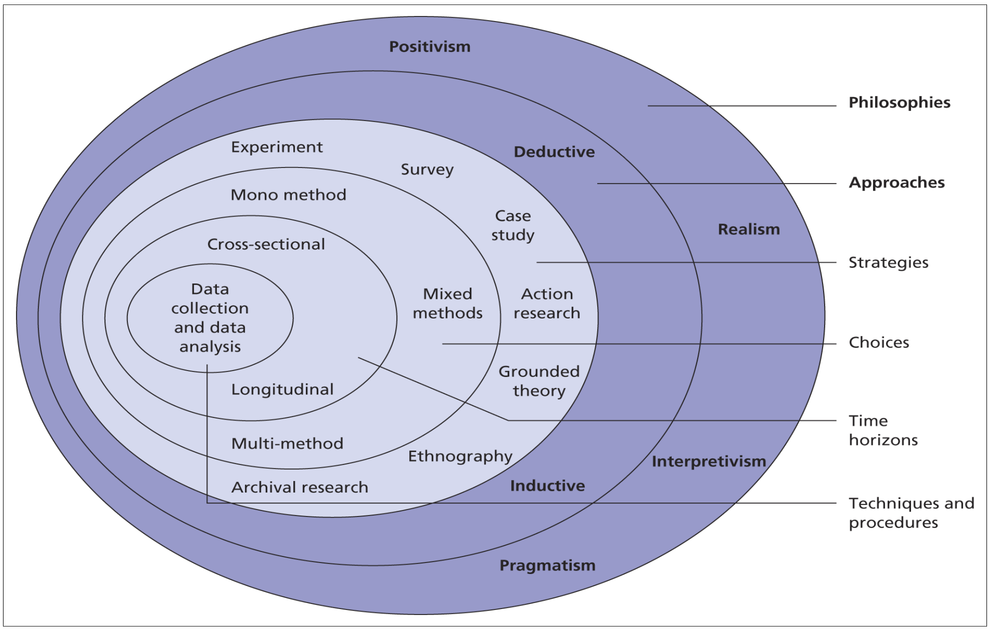
Figure 1: Examples of research paradigms

Research paradigm	**Positivism**	**Phenomelogy**
Ontology	Realism	Constructivism
Epistemology	Empiricism	Interpretivism
Methodology	Quantitative	Qualitative
Research Methods	Fixed design	Fixed/flexible design

The problem with the research paradigm approach is that the other research paradigm options may be prematurely excluded from serious consideration without due diligence and each paradigm may have multiple options for methodology and research methods.

Another approach will be to start from any of the ontological, epistemological, methodological and method deliberations (Crotty 1998, cited by Mack, 2010), but may suffer from poor logical developments of the arguments. The perhaps more popular approach is to use the research ‘onion’ approach of first examining the outer ontology onion layer, then the inner epistemology layer, then methodology layer and finally the inner most method layers, as shown in Figure 2 below (Saunders et al. 2009).

Figure 2: The research 'onion' (Saunders et al. 2009 Figure 5.1)



Grix strongly supports the research onion approach of "setting out clearly the relationship between what a researcher thinks can be researched (her ontological position) linking it to what we can know about it (her epistemological position) and how to go about acquiring it (her methodological approach), you can begin to comprehend the impact your ontological position can have on what and how you decide to study" (Grix, 2004, p.68). The strengths of the research 'onion' approach are that the structure of the discussions of the research design is easier to logically present and the other non-selected epistemologies and methodologies are given better consideration. Thus my deliberations of the research design will follow the research 'onion' approach.

2.2 Choice of epistemological stance

There are three major families of epistemological positions; positivism, interpretivism and critical science and a fourth minor family of feminist (Neuman, 2005). The assignment will argue that the nature of reality of 'key concepts' can be best served by interpretivism, and not by positivism, critical science nor feminism.

Positivism was first formally presented by Auguste Comte in 1830-1842 and believes that there is a very objective external world that can be learnt using senses with as little subjectivity as possible, in an accurate, reliable and valid manner in order to arrive at the absolute truth that is universal (Neuman, 2005; Sarantakos, 2005). Positivism is not appropriate because it is hard to force 'concepts' towards an absolute truth and to validate concepts because 'concepts' are easily entangled in subjectivity (Neuman, 2005; Sarantakos, 2005) and are based on the understandings of individuals. Positivism is more suited to a nature of reality of physical matter/phenomenon, such as in the traditional hard sciences of physics and chemistry, rather than on how people understand physical matter/phenomenon.

The second epistemological family considered was critical social science. Critical social science is geared on revealing the underlying factors that make people want to change situations to ensure a better tomorrow and has gained traction and ground in research on class and societal subgroup struggles, such as conflict theory, feminism and Marxism (Neuman, 2005). The ‘key concepts’ of an anatomy curricula are not about class struggles and makes critical social science unsuitable as an epistemology. It is exceptionally hard to find research on curricula being housed under a critical social science epistemology. The minor family of feminism is definitely not appropriate as the ‘concepts’ of an anatomy curricula are not focusing on gender perspectives at all.

The current assignment advocates for an interpretive social science epistemology after eliminating positivism, critical social science and feminism as the appropriate epistemology for ‘key concepts’ for an anatomy curricula for physiotherapy. Interpretive social science encourages subjective knowledge, the researcher to be more intimate with the nominal nature of reality in order to understand the subjective interpretations (Neuman, 2005) and is popular in studies of curricula development (Gruender and Tobin, 1991; Ernest, 1993).

There are many subgroups within the interpretive social science epistemology, such as “hermeneutics, constructivism, ethnomethodology, cognitive, idealist, phenomenological, subjectivist and qualitative sociology” (Neuman, 2005 p.76). The assignment will make a case for using constructivism epistemology because the curricula for physiotherapy shows a strong historic trend of being constructed through reflection of thought and most curricula on science education tend to use a constructivism epistemological approach. In constructivism, "knowledge is a compilation of human-made constructions" (Raskin, 2002), and is particularly concerned with "how we construct knowledge" (Jonassen, 1991). “Physical concepts are free creations of human thought, and are not, even if they seem to be, solely determined by the external world” (Einstein and Infeld 1950, p.31 cited by Von Glasersfeld, 2001). There is a consensus that most of our knowledge, and the standards and procedures we use to have knowledge are “constructed” (p.5) in our minds, such as physics, mathematics and history and their subdivisions(Phillips, 1995). It makes sense to expect that the knowledge of a new anatomy curricula is made, or ‘constructed’, in the minds of the anatomy experts.

There was no mention of physiotherapy as a profession prior to the First World War and the current knowledge of the curricula for physiotherapy has been the product of cognitive construction of knowledge over the last century. Physiotherapy is one of the youngest professions of the medical field that treats patients. Physiotherapy knowledge has grown so much that the creation of multiple categories of physiotherapy specialties were warranted, especially in the last 30 years or so (Latman and Lanier, 2001; McMeeken, 2008). In the United Kingdom, the first PhD in Physiotherapy was achieved in 1981 (CSP, 2013), while the degree was first mandatorily made an entry-level qualification, rather than a diploma, into the physiotherapy profession in 1992 (CSP, 2013).

The second reason for selecting constructivism is because curricula for the education of science disciplines are dominated by constructivistic ideas. Constructivism has grown from an obscure concept (Davis et al, 1990) that began to be discussed as a separate scholarly field in the 1970s (Solomon, 1987) to a “triumphant paradigm” (Martineze-Delgado, 2002 p.840) that was “widely accepted if not dominant” (Arcavi and Shoenfeld, 1992 p.321). Constructivism epistemology has heavily influenced the curricula of how science and mathematics are taught in USA (Novak, 1988; Gruender and Tobin, 1991; Ernest, 1993; Tobin 1993, cited by Jenkins 2000; Olsen, 1996) and in education in general (Von Glasersfeld, 1997). It should not be surprising that the physiotherapy curricula, a science based discipline, has strong constructivistic principles too. The physiotherapy curricula emerged largely from USA and UK in the last century as well, where pro-constructivist paradigms and individuality are cherished (Woodrow, 2001).

2.2.1 Choice of radical constructivism

Constructivism is regarded as an emerging epistemological theory following the decline of positivism, which has been widely and roundly criticised, especially in social sciences (Sarantakos, 2005). The selection of the type of constructivism to use should not be based on the best type of constructivism, but should rather be based on what is most appropriate for the knowledge sought in a study because certain forms of constructivism are more “useful in particular contexts” (Geelan, 1997 p.23).

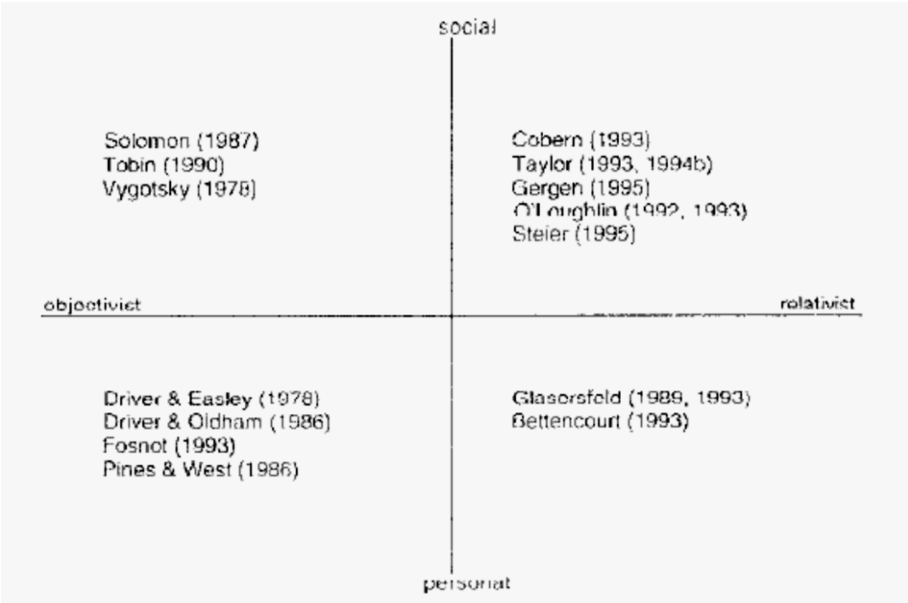
Having found constructivism more appropriate for the type of knowledge that my Research Inquiry will seek, I will now make a well-reasoned and logical selection of a version of constructivism to use. There are many types of constructivism and these range from “contextual, dialectical, empirical, humanistic, information processing, methodological, moderate, Piagetian, postepistemological, pragmatic, radical, rational, realist, social and socio-historical” (Good, 1993, p.1015). These various types of constructivism have been classified by whether the type of constructivism is either personal or social and whether it is either purely relativist or objectivists to some extent (Geelan, 1997). The ‘concepts’ of an anatomy curricula for physiotherapy are highly relativistic and personal for the reasons to be discussed below.

The terms objectivist and relativist have been used within the constructivist circles to refer to a nominalistic nature of reality. Objectivist suggests that knowledge is “monolithic ... and the knowledge is given” (Geelan, 1997 p.21), while relativism points to a plurality of perspectives in knowledge (Geelan, 1997). Whilst it is true that “no constructivist perspectives are entirely objectivist”, the more relative constructivisms are more flexible in defining knowledge than objectivistic constructivisms (Geelan, 1997 p.21). The knowledge of anatomy curricula for physiotherapy appears to be on the relativistic end of Geelan constructivism classification (Geelan, 1997). The highly relative dimension of the ‘concepts’ of the anatomy curricula for physiotherapy has been so strong that it has resulted in the anatomy curricula for physiotherapy being “highly variable” in the USA (Reimer et al. 2013 p.3) and having “no uniform curricula” in Japan (Kawashiro et al. 2009 p.273). The great variability is further evidence that the ‘concepts’ of the anatomy curricula does not have a positivistic basis because a positivistic epistemology is keen on standard knowledge, showing as little deviation as possible from the truth.

The ‘key concepts’ of an anatomy curricula would be more suited by a personal rather than a social type of constructivism. A personal type of constructivism has a “focus … on individual cognition”, while social constructivism include individual cognition but do not make individual cognition a central feature (Geelan, 1997 p.21). The role played by individual anatomy teachers in shaping the anatomy curricula is highly significant because anatomy teachers plan their teaching approach, monitor live feedback from the student during learning, assess the work of the students and review their teaching. The ‘key concepts’ are then created by the anatomy teachers over the years of experience and are profound in how they shape the teaching of anatomy. These ‘key concepts’ are the products of extensive individual cognition and place the knowledge of ‘key concepts’ under a personal type of constructivism.

Having shown that a personal and relativistic from of constructivism are more appropriate for the type of knowledge for my planned EdD Research Inquiry, I will present the diagram by Geelan (1997) shown in Figure 1 that will allow me to choose from the versions of constructivism that are both personal and relativistic.

Figure 3: A classifications of different types of constructivism Geelan (1997 p.20)



The only two versions of constructivism that are personal and relativist from the Geelan constructivism classification (1997) are the Bettencourt constructivism and radical constructivism (Von Glasersfeld, 1984; 1990). Radical constructivism is my epistemological choice because radical constructivism is perhaps the most clarified, detailed and comprehensive constructivism, not only among personal-relativist constructivisms, but also amongst the entirety of the cognitive constructivism and is the most modern version of constructivism (Olssen, 1996). The Bettencourt constructivism is considered a subset of radical constructivism with different terminology (Geelan, 1997).

2.2.2 The relevance of Radical Constructivism to the research design

The most eminent of the personal constructivism version was the radical constructivism coined by Von Glasersfeld. Von Glasersfeld, the most distinguished writer on radical constructivism (Hardy, 1997), wrote extensive writings that may have given Suchting (1992) the wrong impression that Glasersfeld is the 'originator' of constructivism. Gil-Pérez et al. (2002), on the other hand, feels that Glasersfeld's contribution was "negligible" (p.559) after he bean counted Glasersfeld's publications on constructivism. However, Glasersfeld's contribution to constructivism are among the most cited in constructivism.

There are three main key principles associated with radical constructivism: ontological relevance, the role played by experience and highly individualistic knowledge.

2.2.2.1 Ontological relevance

Radical constructivism only supports a nominal ontological view of Burrel and Morgan (1979). because of the emphasis on human concepts, Von Glasersfeld, in contrast, described the nominal ontological view of radical constructivism as “ontologically neutral” (Ernest, 1993 p.90) because scholars of the time in the 1970s had an ontological view of objective and physical reality. Radical constructivism was hinted as "postepistemological" by the inventor Von Glasersfeld (1993, p.24) because radical constructivism discarded some key assumptions of epistemology in the 1970s, such as that knowledge is meant to portray the objective reality in the world. Radical constructivism differed greatly or ‘radically’ from most common epistemologies of the 1970s in that knowledge is not out there waiting to be discovered but is only found in the minds of people (Von Glasersfeld, 1984).

The perceived lack of an ontological basis due to the ontologically neutrality connotations (Glasersfeld, 1989) has resulted in critics slandering radical constructivism as being full of solipsism by the positivistic camp (Martínez-Delgado, 2002). Solipsism is the complete denial of the physical world and only what is generated by the mind is important (Martínez-Delgado, 2002). Glasersfeld (1996) defended the solipsism attack by stating that objective reality is not fully understandable and the knowledge of the objective reality cannot be depended upon as the true reflection, under the radical constructivism rules (Glasersfeld, 1989). Our knowledge and concepts of the world partially depends on the physical external world (Glasersfeld, 1996). So “radical constructivism is consistent with the idea of a real existing world outside. All radical constructivism denies is the possibility of any certain knowledge of that reality (Duit, 1993 p.23).

Most discussions on radical constructivism mention two types of reality: traditional reality (objective realism) and ‘invented reality’ (nominalism). Objective realism is not fully knowable in radical constructivism because of our perception and cognitive limitations, and the closest to reality in the traditional sense is ‘invented reality’, which is the “experiential world of the knower” (Von Glasersfeld, 1996 p.307). No wonder Watzlawick, (1984) entitled his book ‘The Invented reality’ when referring to knowledge in radical constructivism. Radical constructivism suffers from having no regard for knowledge that portrays the golden standard truth (Von Glasersfeld, 1990) because it is impossible to have full knowledge of the traditional sense of objective reality, a “forever unattainable ontological test” (Von Glasersfeld, 1989 p.129). The current assignment will focus of the knowledge of the ‘invented reality’ that Burrel and Morgan (1979) would classify as nominalism.

So could every thought and whim that people think of be classified as knowledge? Not so, radical constructivism creates viability and prediction thresholds of what can be classified as knowledge. Radical constructivism has a fascination with viability at the expense of the concept of truth, as most people understand (Von Glasersfeld, 1990). In radical constructivism, knowledge of the 'invented reality' does not perfectly fit the objective reality in the world because the mental constructions of different people maybe constrained differently by the same external objective reality (Hardy, 1997), time and culture. Consequently, people interpret and understand the same external objective reality differently. However, that knowledge of the 'invented reality' should be viable, in the sense of being consistent with the past experiences of individuals and also that knowledge should be able to make future forecasts and likelihoods (Von Glasersfeld, 1984). There are no grades of viability, viability is either present or not (Osbourne, 1996). The double lock of viability and prediction value prevents people from dreaming things into becoming the 'invented reality' (Von Glasersfeld, 1990; 2001). Experience alone, if properly done, could be sufficient as a viability test, because constructs that do not predict future things are discarded on the basis of experience (Von Glasersfeld 1981, cited by Hardy, 1997). It is perfectly fine to have many constructs for the same external world and should not tempt people into grading some constructs as being more viable than others, although qualitative grading of the constructs can be made (Von Glasersfeld, 1984). While positivists paradigms see truth as certain and foolproof (Neuman, 2005), radical constructivism takes a more flexible stance of judging knowledge on the basis of having both viable and predictive elements.

2.2.2.2 Relevance of experience

Experience plays a large role in radical constructivism because knowledge is constructed by navigating through experiences (Fosnot, 1996; von Glasersfeld, 1996) and is heavily influenced by the environments and symbols around (Fosnot, 1996). The way experience creates knowledge in radical constructivism in the cogniser is very interesting. Experiences that do not make sense are the main triggers of new knowledge in radical constructivism (Von Glasersfeld, 1989). Experience invariably involves social interaction, which lies at the heart of radical constructivism (Hardy, 1997), because knowledge is individually made in a social context (Miller and Diver, 1987). Social interaction is the most potent tester of mental constructs (Von Glasersfeld 1991, cited by Hardy, 1997) and the most frequent source of triggering mental constructs (Von Glasersfeld, 1989). It must be borne in mind that the newly constructed concept can only be retried by the subject and from no other source (Von Glasersfeld, 2001).

The current assignment treats the physiotherapist-anatomist expert as the knower who has been influenced by many of their past experiences to determine the most important 'key concepts' required when designing an anatomy curricula for physiotherapy undergraduates. These highly experienced teachers would have had encountered a rich history of teaching and learning experiences that would have not made sense initially or nuggets causing deep reflection on their teaching. They would have create constructs in a bid to resolve the nonsensical behaviour, results or seeds of deep reflection. The ability of the people to analyse, find trends, patterns and differences of past experiences and link them to present experiences is key to making useful mental constructs (Von Glasersfeld, 1989), such as the experts in my study who will have a wealth of experience in teaching anatomy. Radical constructivism holds dear the 'readiness-to-learn' principle, which means that for a knower to generate new knowledge, the knower must be academically ready to process it (Steffe and Kieren, 1994) and affects the choice of subjects. My subjects, as experts with physiotherapy and anatomy qualifications, have enough experiences to foster reflection surrounding the 'key concepts' of anatomy curricula for physiotherapy.

2.2.2.3 Knowledge is highly individual

The way questions and criticism on radical constructivism has been put forward has been intoxicated by an objectivistic motive (Hardy, 1997). A poor account of intersubjectivity is one of the things that irritated critics have levelled against radical constructivism (Suchting, 1992).

In radical constructivism, knowledge among subjects is highly individualistic and different among individuals and can potentially cause problems in discussing the same issue. Radical constructivism has been criticised for not having common threads between knowers and challenges how two knowers can ever communicate effectively, especially between the teacher and students if both have their own personalised view of a certain piece of knowledge (Cobb, Wood, and Yackel, 1992). Although constructivism creates different constructs/knowledge of the same objective external reality among different people, the constructs/knowledge are generally functionally similar otherwise people would be creating wild constructs of reality of things they like (Von Glasersfeld, 1990). Parts of reality affects us in a similar way, e.g. we cannot walk through walls and desks, and this accounts for similarity of constructs/knowledge across subjects (Von Glasersfeld, 1990).

The solution to the highly individualistic knowledge is that a portion of the subjective and individualistic knowledge each subject has can termed as "taken-as-shared-interpretation", if their different constructs functionally operates similarly in a given circumstance (Cobb et al. 1992 p.13). The taken-as-shared-interpretation in radical constructivism is for similar common knowledge and is different from the approach taken in social constructivism where different constructs by different stakeholders complement each other in making a more complete theoretical picture.

2.3 Choice of methodological stance

Grounded theory has earned respect as being able to allow theory of concepts to emerge from interview transcripts (Corbin and Strauss, 1998)**.** This section of the assignment will make an appraisal of the relevance of grounded theory to radical constructivism.

Grounded theory methodology is about 50 years old and was invented by Glaser and Strauss (Glaser and Strauss, 1967). The grounded theory methodology has had over dedicated 3500 journal articles, has evolved in diverging angles over the years to satisfy and justify the different epistemological positions (Mills et al., 2008) and account for ever changing winds of dominant epistemological themes in qualitative research across the decades (Annells, 1997). There is even now a dedicated journal called 'Grounded Theory Review' (2014).

The original classical ground theory encouraged researchers to be open minded and have no preconceived ideas about the analysis or results and surprisingly did not mention any epistemological loyalty (Glaser and Strauss 1967; Glaser, 2002) and was declared free of any epistemological poses by Glaser (Glaser 2005, cited by Breckenridge et al. 2012). However, such epistemological neutrality is "an epistemological fairytale" (Bryant, 2009, para.13) because the data in the classical grounded theory was treated in a positivistic way, with the researcher being completely passive to allow the data to speak for itself (Annells, 1997; Bryant, 2009). Some have argued that the classic grounded theory unwittingly imbibed a postpositivistic epistemology because it was coined an era dominated by postpositivism (Harris, 2003), and a good decade before the formal birth of constructivism (Solomon, 1987). However, in contrast to Glaser's call for epistemological neutrality of the classic grounded theory (Glaser 2005, cited by Breckenridge et al. 2012), "epistemology is inescapable" (Carter and Little, 2007 p.1319) and defending a particular epistemological standpoint is a necessity for doctoral students and young researchers as myself, and being numb to epistemological discussions is not good enough.

In a bid to address the alleged epistemological vacuum by the inventors of grounded theory, modifications were made to the classical grounded theory to suit various epistemologies (Mills et al. 2006; Breckenridge et al. 2012), such as feminism (Wuest and Merritt-Gray, 2001), critical thinking (MacDonald, 2001), postmodernism (MacDonald and Schreiber, 2001) and constructivism (Annells, 1996; Charmaz, 2006). In fact, "people can find support in it (grounded theory) for any ontology that they wish" for (MacDonald and Schreiber, 2001, p.44).

Charmaz, the first constructivist ground theorist and the second generation of ground theorists, was fortunate to have studied grounded theory research under the watchful eyes of the inventors Glaser and Strauss, and she is a staunch advocate of using a constructivism epistemology in grounded theory (Mills et al. 2008). Charmaz's Grounded theory with a constructivism epistemology has been widely used in education (Jones and Hill, 2003), psychology (Corbet-Owen and Kruger, 2001) and health (Gustafsson, 2003). One striking difference between the constructivist blend of grounded theory and other grounded versions was that the researcher is part of the creation of the knowledge (Charmaz, 2006). The interplay of the researcher and interviewees "produces the data, and therefore the meanings that the researcher observes and defines" (Charmaz, 1995, p.35 in Mills et al. 2008).

There is lots of support that constructivist epistemology involve double construction of meaning because the knowledge initially constructed by individual minds of subjects is then reconstructed in the researcher's mind during analysis (Pidgeon and Henwood, 1997; Charmaz, 2006; Mills et al. 2008), as the second layer of construction of knowledge (the first layer being the creation of the 'concepts' of an anatomy curricula by individual anatomy teachers). The construction on the part of the researcher is not at all peculiar, the analysis of the objective knowledge in positivism is a form of researcher reconstruction in a way.

Both layers of construction of knowledge will have to pass the standard of proof threshold tests of viability and predictive usefulness, as per the radical constructivism epistemology (Von Glasersfeld, 1990; 1993), to qualify as knowledge. The first layer of constructing knowledge by anatomy teachers will have to be viable in the experiential world of the individual anatomy teachers and being predictive of effective future pedagogic practices. The second layer of construction of knowledge in the researcher's mind will have to be viable and consistent with the interview communications and interview transcripts, and will have to be predictive of future interviews. No wonder the interviews will stop once data saturation is reached (Strauss and Corbin, 1998). If knowledge passes the standard of proof of knowledge for the second layer of construction, than the researcher's mind will have created knowledge of the 'key concepts' of running an anatomy curriculum.

The part played by the researcher in constructing knowledge will have implications for the researcher in the method and will be further discussed in the next section.

2.4 Choice of methods

The constructivistic version of grounded theory method will be used to systematically extract the theory from the data (Charmaz, 2006). Knowledge of the key ideas for a curricula are constructivistic, where knowledge is individualistic, subjective and distinctive and requires intimate interaction between the researcher and the subjects (Cohen et al. 2007). Such a close proximity to subjects is called an idiographic approach (Burrell and Morgan, 1979), such as interviews.

2.4.1 Research design plan before interviews

2.4.1.1 Ethical approval

The unfunded research proposal will be submitted for ethical approval to the Faculty Research Students Committee based on the 'Ethical Guidelines for Educational Research' of the British Educational Research Association (BERA, 2011) before contacting the research subjects. Informed and signed consent will be obtained before the interviews. There are one ethical problematic areas for the proposed research. The research data will be stored in encrypted storage devices and anonymity preserved in write-ups in compliance with the Data Protection Act (1998). Extra care will be taken when using direct quotes to make sure that the quotes cannot be traced back to the individual subjects, given that the grounded theory methodology heavily relies on maintaining direct quotes in the memo notes and in the thesis write-up. Keeping direct quotes of the subjects in the memos and written reports helps to keep the subjects thoughts throughout the process (Charmaz, 2006).

2.4.1.2 Choice of research participants

I am hoping to use in-depth open interviews with about 15 experts (ideally until data saturation), who are both physiotherapists and anatomists with over ten years of anatomy teaching experience. Eight years' experience has been chosen because an anatomy teacher will need some years to allow 'effective' concepts to be created and constructed from their teaching reflections. The anatomy teachers will need further years to implement their newly created concepts to test their predictive value, and modify them if the concepts need modifications, until robust and effective concepts for running anatomy curricula for physiotherapy emerge. The anatomy teachers will need to be qualified physiotherapist in order for them to foresee how an anatomy curriculum could be of use to the individualised physiotherapy experiences of students. While there may be other useful knowledge in people with different and probably competing interests, other than the targeted participants of anatomy teachers, such as administrators and former students, the knowledge of other stakeholders in teaching anatomy will be not be as rich in knowledge as the knowledge in the anatomy teachers' minds.

The identification of the Physiotherapy Lecturers teaching anatomy in the UK will be carried out in three phases: internet-based search, snowballing phase and a pre-interview survey. A Physiotherapy Lecturer will be defined as a person with a university title of Lecturer or higher and having live registration with the Health and Care Professions Council of UK as a Physiotherapist. For the purposes of this study, a person was defined as teaching anatomy if that person taught anatomy to any of the physiotherapy pre-registration degree programmes.

2.4.1.2.1 The Internet-based search phase

Physiotherapy education is only permitted in the UK in approved universities by the Health and Care Professions Council and the title of "Physiotherapist" is protect by the Articles 39 and 39A of the Health and Social Work Professions Order 2001 Law (HCPC, 2015). A systematic internet based search was made to identify all the universities in UK offering physiotherapy degrees from the HCPC (2015) website. The HCPC (2015) website identified 37 universities (as shown in Table 1) offering both or either of the two forms pre-registration physiotherapy degrees: a BSc Honours Physiotherapy or MSc Physiotherapy degrees. Only 35 of the 37 website links yielded contact details because the London South Bank University was found to have no physiotherapy degree programmes and the Bournemouth University website was currently unavailable. The university websites were followed and led to the retrieval of the names, email addresses and telephone numbers of Physiotherapy Lecturers teaching anatomy or key people who might know them, such as the Heads of the Physiotherapy School, Physiotherapy Administrators and the Course Leaders for the Physiotherapy degree programme. Some of the general university websites were so difficult to navigate to show Physiotherapy Lecturers teaching anatomy that the author had to use Google Search (2015) website to find Physiotherapy Lecturers teaching anatomy, after typing the name of the university, "staff", "anatomy" and "physiotherapy" words into the search box. The internet-based search phase took about 80 hours to complete.

Table 2: Summary of contact details of Physiotherapy Lecturers teaching anatomy retrieved during the internet-based search

	Categories of persons with contact details retrieved									
	Type of starting university website	Heads of PT School	BSc PT Programme Course Leaders	MSc PT Programme Course Leaders	General PT School Contact details	PT Administrators	PT Lecturers (?? Anatomy Teaching)	Anatomy Lectures (?? PT Qualifications)	PT Lecturers Teaching Anatomy	Other Interesting contacts
Bournemouth University	D	0	0	0	0	0	0	0	0	0
Brunel University	G	1	1	1	0	0	0	0	1	1
Cardiff University	G	0	2	1	1	0	0	0	3	0
Coventry University	G	0	1	1	0	0	0	0	0	0
Glasgow Caledonian University	G	2	0	0	0	0	0	0	2	0
Keele University	G	1	1	1	0	2	0	0	2	1
King's College London	G	2	0	0	1	0	0	0	0	1
Leeds Beckett University	G	0	0	1	0	0	0	0	0	0
London South Bank University Could not find PT degree programme	G	0	0	0	0	0	0	0	0	0
Manchester Metropolitan University	F	1	0	0	0	0	0	0	5	0
Northumbria University	G	0	1	0	0	1	0	0	0	1
Oxford Brookes University	D	1	0	0	1	0	0	0	1	0
Plymouth University	G	0	1	0	0	0	0	0	3	0
Queen Margaret University	G	0	1	1	0	0	0	0	0	0
Sheffield Hallam University	G	0	0	1	1	0	0	0	0	0
St George's, University of London	G	1	0	1	1	0	0	0	0	0
Teeside University	G	0	0	0	2	0	0	0	0	0
The Robert Gordon University	G	1	0	0	0	1	0	0	0	1
University of Birmingham	G	0	1	1	1	0	0	0	1	0
University of Bradford	G	0	0	1	0	4	0	0	0	0
University of Brighton	G	2	0	1	1	0	0	0	0	0
University of Central Lancashire	G	0	0	0	1	0	0	0	0	0
University of Central Lancashire	G	1	2	0	1	0	0	0	2	0
University of Cumbria	G	0	1	0	0	0	0	0	2	0
University of East Anglia	G	0	0	0	1	0	0	0	2	0
University of East London	D	0	2	0	1	0	0	0	0	0
University of Essex	G	1	0	0	0	1	0	0	0	0
University of Hertfordshire	G	0	1	0	1	0	0	0	0	0
University of Huddersfield	G	0	0	0	1	0	0	0	0	0
University of Liverpool	G	1	1	0	0	1	0	1	8	0
University of Nottingham	G	1	1	0	1	1	0	0	0	0
University of Salford	F	2	2	0	1	0	0	0	1	0
University of Southampton	D	0	1	0	1	0	1	0	0	0
University of the West of England	G	3	1	0	0	0	0	0	0	0

University of Ulster	G	1	0	0	1	0	0	0	0	0
University Worcester	G	1	1	0	0	0	0	0	3	0
York St John University	G	1	1	0	0	1	0	0	1	0
Explaining Abbreviations used										
PT = Physiotherapy										
Type of starting university website = Whether the website given by the HCPC (2015) website was for th main university website (H), Faculty website (F) or the website for the Physiotherapy degree programme (D)										
?? Anatomy Teaching = not sure if the person teaches anatomy to physiotherapy students										
?? PT Qualifications = not sure if the person has physiotherapy qualifications										
Explaining Colour codes used										
	Means no email address was available									
	Means neither email nor the telephone was available									
	Means that the university website was not available or pre-registration physiotherapy degree programme did not exist									

2.4.1.2.2 The snowballing phase

The information on the university websites identifying Physiotherapy Lecturers teaching anatomy was neither completely up-to-date nor comprehensive. Hence, the contact details of key people who might know the Physiotherapy Lecturers teaching anatomy will be used to determine full complement of Physiotherapy Lecturers teaching anatomy at each university during the snowballing phase. The snowballing phase will involve calling the telephone numbers obtained in Table 1 to verbally ascertain the correct contact details of the Physiotherapy Lecturers teaching anatomy in each university. The snowballing search phase is expected to take about 30 hours to compile.

2.4.1.2.3 A pre-interview survey

The purpose of the pre-interview survey will be to enable the author to choose the most appropriate sampling technique for selecting the Physiotherapy Lecturers teaching anatomy with the richest knowledge. The survey will be emailed to the Physiotherapy Lecturers teaching anatomy to physiotherapy degree programmes obtained after the Snowballing Phase. The Physiotherapy Lecturers teaching anatomy will be ranked according to richness of their knowledge that most effectively teaches physiotherapy students to learn anatomy useful for their future clinical experiences. Crude indicators of the richness of knowledge such as qualifications and experiences listed in Table 2 will be used to rank the participants.

Table 2: Pre-interview Crude indicators of the richness of knowledge

Category	**Aspect**
Demographic data	Name of current post
Qualifications	Physiotherapy Qualifications
	Anatomy Qualifications
	Teaching Qualifications
Experiences	Number of years spent teaching anatomy to physiotherapy students
	Writing an anatomy textbook
	Designing an anatomy curricula for a degree programme
	Cadaveric dissection experiences
	Assessing how students use anatomical knowledge in the clinical setting

2.4.1.3 The treatment of literature

The timing of when to conduct a literature review in grounded theory has been much debated between two academic camps: one is support of a literature review 'before' interviewing and the other camp supporting a literature review 'after' the start of the interviews. The main proponents of performing the literature review 'after-the-interview-start' were the founders of grounded theory, Glaser and Strauss, and encouraged researchers to "at first, literally to ignore the literature of theory and fact on the area under study" (1967, p.37), in a bid to reduce the risk of literature ideas contaminating the concepts to be discovered in a new study (Glaser, 1998; Glaser, 2002). Anyway, literature is far more extensive to be fully reviewed before starting a study (Glaser, 1998; Locke, 2001). The 'after-the-interview-start' approach has support from a number of scholars (Charmaz, 2006; Nathaniel, 2006; Holton, 2007).

Strauss later changed his mind and forms part of the 'after-the-interview-start' camp after realizing problems with the 'after-the-interview-start' position (Wiener, 2007; Strauss and Corbin, 1990). It is hard for Phd students to secure funding, ethics approval and first year progression without a research proposal based on a comprehensive literature review before interviews (Dunne, 2011). Little researched areas are eligible candidates for using grounded theory (Payne 2007, cited by Dunne 2011), such as the anatomy curricula for physiotherapy as indicated under the 'Introduction and rational of the study' section. So if I am not to perform a literature review, how could I have determined that there is little research done on the anatomy curricula of physiotherapy, a problem highlighted by McGhee et al. (2007), or avoid research duplication (Chiovitti and Piran, 2003). A prior literature helps to contextualise a proposed study McCann and Clark, 2003a) and helps to avoid thinking and methodological blind-spots (McGhee et al. 2007) that may leave one's research vulnerable from academic criticism. Had I not done a literature review on grounded theory, I would not have known that even the timing of a literature review would have been an issue, a point also highlighted by Dunne (2011). The desire for an "empty vessel (researcher) … with no history or background" (Cutcliffe, 2000 p.1480) is impossible to find in established and experienced scholars (Clarke, 2005; Charmaz, 2006). The relevant acquired knowledge, experiences and research experiences of an undergraduate and a master's degree are mandatory for most doctoral degree programmes and challenges the mirage of the 'tabula rasa' state of grounded theory researchers of the 'before-the-interview-start' position. Indeed, "one can never enter a research area with an empty head; one can try to do so with an open mind" as Bryant (2009 online page) rightly said. Some of the concepts in designing curricula are complex and it helps to be abreast of the concepts in order to meaningfully be able to follow the interviews, as indicated by Lempert (2007) when he said that "engaging the literature provides the researcher with knowledge of the substantive area in sufficient depth to understand the parameters of the discourse and enter into the current theoretical conversation (p.261).

Very clearly both the 'before-the-interview-start' camp and the 'after-the-interview-start' camp are right in highlighting the research risks of their respective academic positions on the timing of conducting the literature review. On the balance of probabilities, there is an incredibly far higher academic risk of major research mistakes or omissions from a greater academic audience occurring by not conducting the literature review before the start of interviews than of conducting the literature review after the start of the interviews, especially for a doctoral candidate as myself. The greatest care will be placed on avoiding my ideas, experiences and theoretical persuasions from pre-emptying the creation and construction of knowledge emanating from the interviews, in a bid to lessen the impact of the risk of conducting the literature review before the interviews.

2.4.1.4 Analysis

Although many coding techniques of grounded theory have been put forward, some being more prescriptive than others, it is not wise to use a rigid set of techniques, but to allow the data to talk through what it is saying by allowing flexibility of appropriate coding techniques to be used (Strauss and Corbin 1998). Such a flexibility of coding techniques are fertile ground for constructivism epistemology (Mills et al. 2008). I will familiarise myself with the range of coding techniques described in Strauss and Corbin (1998), such as open coding, axial coding, selective coding, coding for process and the conditional matrix, before starting the interviews. Thus being aware of the different coding techniques will be helpful in coding to generate a theory of the 'key concepts' of my Research Inquiry for the anatomy curricula for physiotherapy. There has been recent popularity in using computer software to generate patterns of codes and categories from interview transcripts, but computer judgement is not appropriate in constructivism. In constructivism, the researcher is an important part of creating knowledge and computer software is seriously limited in understanding the highly localised context required to construct knowledge. Software could have been appropriate for a positivism epistemology, where the researcher bias has to be eliminated as much as possible. Hence computer software will not be used in the proposed research design.

2.4.2 Research design plan during and after the interviews

2.4.2.1 Carrying out the interviews

The idea of data generation has been favoured in constructivism paradigms over data collection (Collins, 1998). Data collection seems to have an inclination towards positivism in that knowledge or data should reflect the world out there (Glaser and Strauss 1967, cited by Glaser, 2002), a sort of ‘smash and grab’ approach where the researcher goes in to make a data collection (Collins, 1998). The power of conducting interviews, in terms of practical techniques, such as the subjects choosing the time, location and the structure of the interview, should be shifted more towards the subjects to encourage subjects to give their ‘constructs’ (O'Connor, 2001).

3 The strengths and limitations

The design of the research plan has a number of limitations. While constructivism was born out of scepticism that people can never be sure of having the knowledge truth about objective reality (Olsen, 1996), radical constructivism is still vulnerable to scepticism. The scepticism pointed towards radical constructivism is how can the anatomy experts know for certain that the knowledge they have is accurately describing the modern anatomy curricula, given that each person has different knowledge (Olssen, 1996). On a more abstract level, the scepticism can be extended to ask how does an anatomy expert know that his description of knowledge is a correct portrayal of his own knowledge.

The current research design has the potential of being misunderstood in terms of how knowledge cannot be transferred from one person to another in constructivism, especially from the positivism academic camp (Von Glasersfeld, 1984; 1990). An individual uses his/her understanding to create knowledge and the first layer of creating knowledge is represented by anatomy teacher creating concepts in his/her mind on how to most effectively run an anatomy curriculum for physiotherapy. Once this knowledge is made in the minds of the anatomy teachers, it will have to be reconstructed by my mind (as a researcher) as I apply my understanding to it, to form the second layer of construction of knowledge of the 'key concepts', because the knowledge in the minds of the anatomy teachers cannot be transferred to the mind of the researcher (Von Glasersfeld, 1990). The person/supervisor who will read my finalized assignment or completed Research Inquiry will in turn then make a third layer of construction of knowledge of the 'key concepts' of an anatomy curriculum. Thus, each and every person who applies his/her understanding to eventually come to have knowledge will have in essence have created knowledge, an irritant in the eyes of positivism tainted readers.

There is a danger of the input of the researcher being more significant than the interview data from the interviewees (Glaser, 2002). The role of the researcher helping in creating knowledge has been strongly criticized for introducing researcher bias (Glaser, 2002). The classic grounded theory tried as hard as possible to remove this researcher bias by making sure that the researcher is 'grounded' in the data being examined (Glaser, 2002). As I see it, the researcher bias is a thin veil behind which a positivist vs constructivism epistemological debate is hiding. Bias is not an issue in constructivist circles because each person creates a unique construct of knowledge (Charmaz, 2006). To ameliorate for the researcher bias, I will describe my past experiences, qualifications and attitudes to anatomy curricula, so that the readership of the Research Inquiry might see some of the influence, if any, that I may unintentionally bring into the data generation. My perspectives will be written down before the commencement of the data generation and analysis. Memo notes will be meticulously kept to ensure that the constructing part of the researcher is grounded on the interview transcripts.

There are number of strengths that this assignment carries. The current research proposed is perhaps the first to use a radical constructivistic grounded theory and could pave the way for other educationalists wishing to use it in their research approaches. The radical constructivistic grounded theory took the 'taken-as-shared-interpretation' for similar functional knowledge across subjects, in contrast to the social constructivistic grounded theory, which takes a complementary view of knowledge across individuals (Charmaz, 2006).

The assignment has a research plan that has well explored philosophical and methodological arguments. The research design was built upon foundations of nominal ontological view, epistemology of radical constructivism, methodology of constructivism version of grounded theory and the subsequent relevant practical methods. The assignment offers hope for a conscientious research to generate a theory governing the 'key concepts' for running an effective and modern anatomy curricula for physiotherapists around the world, which could assist the writing of the first ever anatomy textbook for physiotherapists.

4 Conclusion

A research design proposal has been made in this assignment to understand the theory governing the running of effective anatomy curricula for physiotherapy. The rational for the study has been put forward of a young physiotherapy profession and the ontological, epistemological, methodological and method implications have been critically examined. Lastly the strengths and weaknesses of the study were discussed.

The research outcome will positively influence how anatomy for physiotherapy is taught, learnt, assessed and resourced across the world by promoting active student learning. The theory of ‘key concepts’ might influence the designing of anatomy curricula for physiotherapy and the writing of the very first clinically relevant anatomy textbook for physiotherapy.

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2796 words

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Appendix 29: Module 5 - Literature Review (Third Time of Reviewing Literature)

Module 5 Literature Review Hope Gangata

Research Area: The Literature Review for a proposed study entitled: 'The proposed theory based on key concepts involved in running an effective and modern anatomy curricula for physiotherapy practice'

Table of Contents

1 Introduction for the Research Thesis

The current literature review (Module 5) of the Research Thesis is part-fulfilment of the Doctorate in Education degree at the University of Staffordshire. The literature review will explore pedagogical concepts affecting the anatomy curricula for physiotherapists with a view of developing a theory explaining how to run a highly effective and modern anatomy curricula for physiotherapy.

1.1.1 The context of research

Physiotherapy, an essential healthcare service worldwide (APTA 2003), is the use of movement, advice and education to treat various movement-related health conditions (CSP-Physiotherapy-Definition 2014). Although physiotherapy is a relatively young profession allied to medicine, about 100 years old (Richardson 1999), it is actually one of the oldest and biggest groups of allied healthcare staff in developed countries (Nicholls & Cheek 2006). The body of physiotherapy knowledge has swelled up (Crosbie et al. 2002; Krause et al. 2006) to more than forty fields of specialisation in UK (in the old Appendix 1). Both the number of physiotherapy schools and physiotherapists have ballooned (Latman & Lanier 2001; McMeeken 2008; Reimer et al. 2013). Anatomical knowledge, especially musculoskeletal anatomy (Mattingly & Barnes 1994; Kawashiro et al. 2009), is fundamental for effective physiotherapy (Mattingly & Barnes 1994; Latman & Lanier 2001; McCuskey et al. 2005; McMeeken 2008; Thomas et al. 2011; Khan et al. 2015).

However, the development of anatomical pedagogy been neglected, especially in the UK, and there is over reliance in traditional teaching methods depending on lectures and cadaveric dissections (Latman & Lanier 2001; Reimer et al. 2013; Khan et al. 2015). Anatomy is a challenging subject to learn (Clancy et al. 2000; Johnston 2010; Bergman et al. 2011; Khan et al. 2015) and pedagogical guidance will be helpful. New areas of specialisation which have emerged require relevant anatomical knowledge (Mattingly & Barnes 1994). There is poverty of conceptual and theoretical perspectives to guide the pedagogy of anatomy for physiotherapy. The lack of appropriate anatomy textbooks has resulted in physiotherapy students using anatomy textbooks for medical students (Mattingly & Barnes 1994).

1.1.2 Purpose and aims of the literature review

My initial aim, about three years ago, for the research thesis was to map out the most suitable and standardised breadth and depth of anatomical content to teach to physiotherapy students worldwide and the literature review was meant to critique the current anatomical content for physiotherapy. During the course of my examination of literature, I became increasingly aware that developing pedagogic theory would be more useful than creating a static list of anatomical content because pedagogic theory would capture the most significant intricacies of the underlying factors, would have rational explanations that could be engaged with, would have the potential for making predictions, make contextual considerations and could be grounded in current educational practices. How a given anatomical content is pedagogically delivered has a profound influence on how anatomy is learnt and supports the pedagogical theory approach. The shift towards theory generation then moved me to review concepts and theories in literature (and their historical context) that explain how anatomy for physiotherapy is learnt.

The main purpose of the literature review is to critically analyse pedagogical concepts and theories in use in the current practices for teaching and learning anatomy for physiotherapy. The current concepts will encompass the concepts used to craft the teaching/learning of anatomy, such as concepts governing the selection of anatomical content and assessments. The lesser purpose of the literature review is to provide a historical contextual background of the concepts influencing the teaching of anatomy for physiotherapy in the UK because, as the author is based in the UK, it will be logistically and financially convenient to conduct the research interviews in the UK and implement the new findings in his educational workplace here.

1.1.3 Rationale for the study

My personal motivation for the EdD research was started by the fact that I was the first clinical physiotherapist to specialise in anatomy in my country of birth, Zimbabwe, as indicated in my autobiographical book summary on Appendix 19 on page 254. Throughout my 15 years of teaching anatomy at four universities, anatomy for physiotherapy was taught by non-physiotherapists (scientists or medical doctors) who had very limited understanding of the clinical physiotherapy relevance of anatomical structures or a narrow outdated perception of the current scope of physiotherapy. The non-physiotherapist anatomy teachers found it hard to determine what breadth or depth of anatomical knowledge physiotherapy students had to learn or how to structure and assess the anatomical knowledge in a way that promoted effective learning of anatomy in physiotherapy students. The non-physiotherapist anatomy teachers found pedagogical innovation daunting and felt more comfortable in teaching anatomy the same way it had been taught in the department for years. As an upcoming anatomist-physiotherapist academic, I have lacked the pedagogical guidance of senior anatomist-physiotherapists in the four universities I have worked at because they are rare. I am using the current literature review to alternatively help me understand the pedagogical limitations of anatomy for physiotherapy.

I hope to develop my pedagogical expertise from the EdD research to be able inspire to effective learning of anatomical knowledge by physiotherapy students and in future write a well-respected book on anatomy for physiotherapy after my EdD. The new pedagogical theory will help anatomy teachers for physiotherapy to better align their resources, practice and assessments for more effective student learning.

2 Literature Review Chapter

2.1 The methodology of the literature review

As is common with qualitative literature searches, the current literature review was not a linear process (Finfgeld-Connett & Johnson 2013). The literature review started in January 2012, before the research design in APPENDIX 28 from page 264 that started in July 2013 and ended in June 2014, and was left roughly as a 10000 word draft literature review by the time the research design was concluded.

The literature search started with typing the List-A to List-D words in APPENDIX 25 from page 261 into the Google-Scholar website (Google-Scholar 2015) and Pubmed website (Pubmed 2015). Subsequent papers were found by following up the relevant references found in the initial papers. Automatic journal alerts of the table of contents of new issues of the Journal of Higher Education, European Journal of Physiotherapy, Anatomical Science Education Journal, Journal of Clinical Anatomy, Journal of Medical Education and Medical Teacher Journal were setup to try and keep up-to-date with new papers that might be relevant. Further automatic email alerts were setup with Google Scholar Alerts on (Google-Scholar 2015) with the words “physiotherapy anatomy teaching” and “physiotherapy anatomy teaching”. Retrospectively, the author could have kept a weekly journal of the major thoughts on the literature review to have a better grasp of how themes were evolving.

The main findings of the draft literature review fed into the research design in APPENDIX 28 from page 264, where the most appropriate epistemology, methodology and methods were selected on the basis of best answering the main research problems that emerged, and in turn the research design influenced the literature review. The research designing of the proposed thesis in APPENDIX 28 from page 264 culminated in the choice of the ground methodology that gave the author hesitation on whether it was appropriate to have started with conducting the literature review in the first place. The timing of the literature review has been of much contention among scholars of grounded theory methodology and they are divided into two academic camps: conducting the literature review ‘before-the-interview-start’ and the ‘after-the-interview-start’ camps. Conducting the literature review ‘after-the-interview-start’ perspective was born out of the desire to avoid contaminating the data analysis with ideas from the literature review (Glaser & Strauss 1967; Glaser 1998; Glaser 2002; Charmaz 2006; Nathaniel 2006; Holton 2007). On the other hand, the ‘before-the-interview-start’ contingent felt that a prior literature review was important to avoid research duplication, identifying gaps in knowledge, evaluating the worthiness of a research project and allowed more time for the researcher to better understand some of the more complex and relevant issues that might be discussed in the interviews (Cutcliffe 2000; Chiovitti & Piran 2003; Lempert 2007; McGhee 2007; Bryant 2009; Dunne 2011). The author has adopted the 'before-the-interview-start' approach and a fuller discussion of the issue is in APPENDIX 28 from page 264.

2.2 Historical background of anatomy for physiotherapy

A historical background of a research thesis helps to contextualise a proposed research (McCann & Clark 2004). Anatomical knowledge has been a central pillar of the knowledge held by physiotherapy professionals and was actively promoted by the physiotherapy founders and founding societies in Sweden and UK, where the professionalisation of physiotherapy began. The following historic background of anatomy in the physiotherapy profession highlights the high regard that was given to anatomical knowledge through: the high standards of the anatomy examinations, the desire to provide anatomical justification for physiotherapy work and highlights the trajectory of the growth of physiotherapy.

2.2.1 What is physiotherapy?

What physiotherapy is or how it is defined has been relatively fluid in the last century as physiotherapy evolved and grew in scope and reputation. As a result, some of the main books I used while learning physiotherapy did not explicitly define what physiotherapy was (Downie & Boardman 1990; Downie 1993; Kisner & Colby 2002) because physiotherapy definitions were changing too frequently.

The earlier definitions of physiotherapy in 1920 defined physiotherapy as the practice of applying physical treatments to patients, such as massage and exercises (Dimond 1999; French & Sim 2004) and physiotherapists played a subservient role to medical doctors by working as technicians (Wicksteed 1948; Barclay 1994). As a result of increased professional autonomy of physiotherapists over the past century (Dept-of-Health 1977; Barclay 1994; Chambers 2012), the scope of physiotherapy has grown beyond the initial physical techniques. Physiotherapists currently and largely use a much wider spectrum of physical techniques, such as movement and exercise, manual therapy techniques (includes massage, joint mobilisation techniques, joint manipulation and muscle stretching), electrotherapy (electricity-based machines such as therapeutic ultrasound and nerve stimulation), hydrotherapy (movement in water), assistive movement devices (such as physiotherapy taping, wheelchairs, crutch and artificial limbs) (Downie & Boardman 1990; Downie 1993). The idea of changing the body from the outside, rather than from the inside as medical doctors, is a persuasive line of thought for defining physiotherapy (Barclay 1994) and is fading away Physiotherapy has gone beyond the physical techniques and now embraces psychological and cultural influences because most disabilities occur in a social setting and can cause significant mental distress (French & Sim 2004). Physiotherapy treatments have to factor in the social context of the treatment for it to be successful (Parry & Kerr 1997), e.g. the effect of disease and treatment on employment and family responsibilities. Inroads have been made by physiotherapists in the UK into giving drugs to patients and they can now independently prescribe chemical drugs to manage health conditions (Kelly et al. 2008; WCPT 2015; CSP-History 2015) and administer drug injections (CSP-History 2015).

The terms 'physical technique' that was on the CSP-Core-Standards, 2002, definition of physiotherapy was dropped from the later (CSP-Physiotherapy-Framework 2013) definition because of the widening scope of physiotherapy. Such changes to what physiotherapists do is creating identity problems for the profession, especially as other professionals can do some of the similar tasks, e.g. nurses can also give injections (Parry 1995). The idea of targeting physical function in the physiotherapy definition is vague (APTA 2003), as all health professions target physical function, except the pathologists, and more clarity would be helpful.

The Chartered Society of Physiotherapy (CSP) is the largest physiotherapy organisation in the UK and has comprehensively defined physiotherapy recently as an autonomous profession which has emphasised on maximising a person's health and physical competitiveness, within the social context of the patient, through the effects of human movement, and has reference to physical methods (CSP-Physiotherapy-Definition 2014). The terms physiotherapy and physical therapy are synonymous; physiotherapy is used in the rest of the world, such as Britain (CSP-History 2015), Europe (Melguizo et al. 2007; Prados et al. 2007), Australia (Chipchase et al. 2006) Africa (Frantz 2007) and Pakistan (Khan et al. 2015), while physical therapy is used in North America: USA and Canada (Latman & Lanier 2001; APTA-History 2015). Both physiotherapist and physical therapist terms are legally protected titles in the UK (HCPC-Registrants 2015). The first formal reference to the word 'physiotherapy' emerged in Britain when the Association of Teachers of Physiotherapy was formed in 1922 (CSP-History 2015). The term physical therapy was first used in the USA when the American Women's Physical Therapeutic Association was formed in 1921, and later changed its name to the American Physical Therapy Association (APTA) during the 1940s (APTA-History 2015).

2.2.2 <u>The birth of physiotherapy</u>

The presence of anatomy instruction in physiotherapy courses is obscure in literature prior to 1813. There is evidence to suggest that the physiotherapy techniques of massage and exercises had been used since time immemorial and were used in China, India and Greece from 3000BC (Dimond 1999; Öhman 2001; Calvert 2002), but the anatomical rigour of these is hard to ascertain. It was only Per Henrik Ling who started the autonomous professionalisation of physiotherapy by starting a training school in 1813 called the Royal Central Institute of Gymnastics (RCIG) that trained students on the techniques and health benefits of massage and exercise, to levels where it achieved a Swedish Government approved monopoly in 1864 (Bentley & Dunstan 2006; Moffat 2012; Usman et al. 2013). Ling, a keen scholar of anatomy, invented over 2000 anatomical terms describing human movement and positions that went on to be adopted internationally (Öhman 2001) to avoid confusion between practitioners, and made anatomical learning a fundamental feature of the teaching and examinations of the institute (Moffat 2012).

Professionalisation of physiotherapy formally began in the UK in 1894/1895 when the Society of Trained Masseuses (STM) was assembled with a significant knowledge contribution from the Swedish RCIG (Barclay 1994; Moffat 2012). The practice of massage was so variable that it ranged from prescribed massage by a medical doctor, offering sensual relief and to frank prostitution in the extreme form (Wicksteed 1948; Barclay 1994; Nicholls & Cheek 2006). The association of massage with prostitution became such a concern that editorial space for it was created in the leading British Medical Journal (British-Medical-Journal 1894a; British-Medical-Journal 1894b) and in Parliamentary Debates (Parliamentary-Bills-Committee 1894). The STM in essence, copied the nursing professional code by removing sexual or prostitutional inference in the attire, behaviour, working hours and working premises of registered masseuses (Bashford 1998; Coveney & Bunton 2003).

Additional physiotherapy skills, such as exercise and electrical modalities, continued to be used by the registered masseuses and spurred the Incorporated Society of Trained Masseuses (ISTM, the successor of STM) to start examining on Swedish exercises in 1909-1910 (Barclay 1994; Dawson 2013). The Swedish exercises were considered a post-registration qualification and included muscles of the head and neck (Barclay 1994). The Institute of Massage and Remedial Gymnastics, a competitor organisation to the ISTM, fused with the ISTM in 1920 to become the Chartered Society of Massage and Remedial Gymnastics (CSMRG), and was given a royal seal (Dawson 2013). The CSMRG continued swallowing up various smaller physiotherapy groupings until it became the Chartered Society of Physiotherapy (CSP) in 1942 (Dawson 2013). The First and Second World War was a blessing in disguise for the physiotherapy profession because there were many wounded soldiers and civilians who had suffered greatly from aerial bombing and needed physiotherapy treatment (Dawson 2013). Physiotherapy was rewarded by becoming part of the extensive health system called the NHS (Beveridge & Insurance 1942; Dawson 2013) and helped transform the private physiotherapy schools to become state funded institutions. The CSP has grown and currently has over 52000 registered physiotherapists (Finlay 2013).

The feminisation of physiotherapy probably delayed the autonomy of the physiotherapists and had significant pedagogical consequences. Physiotherapy in the UK was frankly called “a feminised occupation” (Dawson, 2013) or "women's profession" (Parry, 1995, p.310). When the STM was setup in 1894 in UK, only women, especially middle class females (Martyr 1997; Nicholls & Cheek 2006), were allowed to join and could only exclusively treat women (Barclay 1994), on what was described as “a female-only affair” (Nicholls & Cheek 2006 p. 2343). Men in the UK were later finally allowed to become ‘semi-recognised’ masseurs in 1905 (Nicholls & Cheek 2006), by passing the final examination, but could not become registered members of the ISTM until 1918 (Dawson 2013) or 1920 (Parry 1995). Male masseurs were needed for wounded soldiers from the First World war in 1914 and in male mental institutions (Barclay 1994) which helped remove the female restriction. Larkin contends that men continued to be banned in practice until 1921 and among the dubious reasons given were that men had substandard educational standings and came from the lower social classes (Larkin 1983). Physiotherapy in the UK remains dominated by White middle class women (Kell & Owen 2008; Yeowell 2013).

Splinter physiotherapy societies emerged that catered for men (Barclay 1994) and shunning of men undermined the formation of an overall physiotherapy association with national authority. Recent calls have been made for men to join the physiotherapy profession and the presence of men is expected to boost the salaries of physiotherapists (Davies 1990). In 1995 in the UK, the then 5% of male physiotherapists showed greater financial ambition and the males took about one-third of managerial physiotherapist posts (Parry 1995). Male students are more likely to want to be independent and autonomous practitioners than female physiotherapy students (Davies 1990). The feminisation of the physiotherapy profession delayed the establishment of professional autonomy for physiotherapists through curtailing what was acceptable physiotherapy knowledge and how it was taught.

2.2.3 The historical background of anatomy teachers for physiotherapy in UK (thesis participants)

A historical background of physiotherapy teachers reveals some of the forces that have sculptured the demography of teachers and provides the author with insight into the potential research participants that the thesis might use. The four core founding members of the STM, from a group of twelve founding women, Barclay, 1994), were professional London nurses (Wicksteed 1948; Nicholls & Cheek 2006; Barclay 1994) who were expected to have received formal anatomical education. The initial education in Britain of massage/physiotherapy students was initially through independent and private schools of massage that ran a massage (Wicksteed 1948; Barclay 1994). Medical professionals, medical anatomists and senior female masseuses taught in the private schools and helped run the registration examinations of the STM (Wicksteed 1948; Barclay 1994; Parry 1995). All the private schools had to have someone who could teach anatomy (Barclay 1994) and the source of their anatomical and pedagogic training was unknown and they were probably self-taught. Students frequently augmented their anatomical education from other places, like hiring skeletons from the Royal College of Surgeons and attending dissection classes from the College of Medicine for Women in London (Barclay 1994).

The final registration examination was run by the massage/physiotherapy societies (Wicksteed 1948; Barclay 1994). The STM crafted a respected curriculum that set and marked examinations (Wicksteed 1948; Barclay 1994; Heap 1995; Nicholls & Cheek 2006). An experienced Anatomy Tutor from the School for Medicine for Women was put in-charge of the examining anatomy for the STM in 1896 (Barclay 1994), which was a cornerstone feature of the STM examination (Moffat 2012). The initial written and oral assessments in anatomy focused on attachments and actions of muscles closer to the skin and bones were optional (Barclay 1994). The first provisional certificates of the STM contained reference to successfully completing anatomical education (Barclay 1994).

The formation of the World Confederation of Physical Therapy (WCPT) in 1951 based in London signalled a new impetus and pushed for minimum worldwide standards (CSP-History 2015). A new two-year post-registration Teachers of Physiotherapy diploma was introduced in the UK in 1951 and had compulsory examinations in anatomy and pedagogical theory and practice (Barclay 1994). The depth of anatomical knowledge learnt was limited and entrenched currently held anatomical knowledge because they had no access to cadaveric dissections and the training had no research component. The physiotherapy teachers made limited impact and generated about twenty graduates per year throughout the 1950s-1993 period, and for example, in 1968, more physiotherapy teachers retired than graduated (Barclay 1994).

Greater physiotherapy autonomy continued in the 1970s when the NHS gave physiotherapists greater autonomy from medical doctors over patients in the UK (Dept-of-Health 1977 cited in Barclay 1994). Physiotherapists stopped requiring compulsory referral letters from a medical doctor for them to treat patients in 1994 (Chambers 2012). University conferred physiotherapy degrees replaced physiotherapy diplomas and became the mandatory minimum qualification requirements to become a registered physiotherapist from 1992 onwards in the UK (Bury

1997) and necessitated several changes. The move to degrees necessitated more analytic learning of anatomy and the simple anatomy Multiple-Choice-Questions (MCQs) were replaced with short-essays questions requiring more critical thinking (Barclay 1994). Prior to making physiotherapy degrees compulsory in 1992, the CSP was very prescriptive on the anatomical content was taught by teachers who had completed the physiotherapy diplomas (Barclay 1994), butcreated a pedagogical vacuum by not giving any pedagogical guidance for anatomy post-1992. Part of the 1992 changes, required Schools of Physiotherapy to be dissolved and be reborn with universities and was a positive development for some because it gave physiotherapy students access to cadaveric dissections used by medical students (Barclay 1994). The 1992 changes made the Teacher of Physiotherapy diploma obsolete and was finally ended in 1993 (Barclay 1994) because teachers with no degrees might have ended up teaching undergraduate students, and indirectly have put pressure on teachers to have masters and doctorates. The transition for teachers of physiotherapy was poorly managed and most probably affected the teaching of anatomy for physiotherapy.

The shortage of physiotherapists with doctorates could be attributed to the late onset of doctorates for physiotherapists. The first UK PhD in Physiotherapy was in 1981 and by 1997, there were about 70 physiotherapists with doctoral degrees throughout Britain (Bury 1997). The first UK Doctorate in Physiotherapy graduate only appeared in 2009 (CSP-History 2015). UK, unfortunately, had no centres of physiotherapy research excellence that were of international repute according to the Higher Education Funding Councils' Research Assessment Exercise ratings (Bury 1997). Recent changes such as introducing entry-level physiotherapy doctorates, mainly in the USA (APTA-Vision 2014), have partly helped in encouraging higher doctorates in physiotherapy in the USA (Rothstein 1998; Hasson 2003), although post-doctoral opportunities in physiotherapy in the UK are rare (Bury 1997). The UK has no plans of introducing entry-level physiotherapy doctorates. Furthermore, there is currently no reward or clearly set-out career path for physiotherapists with doctoral research experience in the clinical hospital setting (Bury 1997). Historically, most health professionals do not have any qualification or training in the practice and theory of education (Harden 1986). Recent changes of making all entry-level academics to achieve fellowship with the Higher Education Academy in the UK have helped the pedagogic skills of physiotherapy academics.

The above literature highlights these points: the research participants of the proposed research will most probably have few degree qualifications in anatomy, have recently acquired doctoral degrees (if they have them), have post-1992 undergraduate physiotherapy degrees and be dominated by females. These constraints have helped create certain inclusion criteria for the research participants. The inclusion criteria for the research participants who have a physiotherapy undergraduate degree and who are registered as physiotherapists with the HCPC will be considered to have been exposed to the basic undergraduate curricula and appreciate the role that anatomy plays in physiotherapy. Eight years of teaching anatomy will be taken as an appropriate inclusion criterion for being a teacher of anatomy instead of possessing anatomy degrees because there might not be enough physiotherapists with anatomy qualifications. The eight years will enable the anatomy teachers to discover curricula concepts that are effective in making physiotherapy students learn anatomy effectively. In summary, the historical background of teachers of physiotherapy in literature has helped pitch the calibre of inclusion criteria of the research participants to a more realistic level.

2.3 Curricula concepts associated with anatomy for physiotherapy

2.3.1 Traditional pedagogy in teaching anatomy for physiotherapy

The choice of pedagogy governing the teaching of anatomy for physiotherapy students has a significant bearing on how anatomy is effectively learnt by students. One of the most popular and most trusted pedagogy for teaching and learning of anatomy for physiotherapy is traditional anatomy pedagogy, which was entrenched by the 1950s (Darcus & Parry 1955) and has remained so until recent times (Latman & Lanier 2001). Most anatomy courses for physiotherapy programs “tend to be fairly traditional and are most likely based upon historical precedence” (Latman & Lanier 2001 p.157). The heavy reliance on the traditional way of teaching anatomy is evident when one looks at recent large surveys into the teaching practices of anatomy for physiotherapy (Mattingly & Barnes 1994; Latman & Lanier 2001; Abdur-Rahman 2007; Melguizo et al. 2007; Prados et al. 2007; Reimer et al. 2013). The surveys are backward looking and encourage popular existing pedagogical ideas (Latman & Lanier 2001) and may not be the best way of conceptualising fresh new pedagogical ideas and theories of teaching anatomy to physiotherapy students. Furthermore, the historical content usually fails to adjust to the advances being made to the scope of the physiotherapy profession (Mattingly & Barnes 1994)

Traditional anatomical pedagogy is characterised by teacher centred lectures augmented by cadaveric dissections in the laboratory during the first year or two of the physiotherapy degree (Mattingly & Barnes 1994; Berube et al. 1999; Latman & Lanier 2001; Abdur-Rahman 2007; Melguizo et al. 2007; Prados et al. 2007; Thomas et al. 2011; Reimer et al. 2013). The use of cadavers in learning anatomy is a highly cherished teaching resource within traditional anatomical pedagogy (Heylings 2002), especially for physiotherapy (Berube et al. 1999; Reimer et al. 2013). Although only 19% of practising physiotherapy clinicians thought that making the students dissect cadaveric specimens was a useful educational strategy, there was an overwhelming 85% of them strongly recommending the use of already dissected cadavers during the learning of anatomy (Latman & Lanier 2001). The trend was confirmed by Kawashiro & Anahara, 2009, and Reimer et al., 2013, who noted that although most physiotherapy schools use cadavers, very few actually make students dissect. The use of cadavers helps students to learn three-dimensional anatomy (Smith 2008), how large or small anatomical structures are and introduces students to human variation. The downside is that a small proportion of students have negative emotional feelings towards the cadavers of preserved dead bodies, often triggered by the smell, seeing the face or contacting a dead cadaver (Kawashiro et al. 2009). Although physiotherapists rarely deal with death in their daily clinical practice, Rojas et al., 2002, recognised the role physiotherapists play in palliative care and cadavers may help physiotherapy students to reflect on human life and dignity (Kawashiro et al. 2009).

There is a common curricular arrangement in physiotherapy schools of placing anatomy earlier in the curriculum, before the clinical courses, of physiotherapy degree programmes (Shepard & Jensen 1990) and can be traced back to the famous Flexner Report, which represents the essence of traditional anatomy curricula (Flexner 1910). The American Physical Therapy Association (APTA) endorsed the full recommendations of the Flexner Report released in 1910 (Linker 2005), which was the most significant document that shaped the way medical and allied health education was taught throughout the 20th century (Miller & Weiss 2011). The report standardised the way in which anatomy was taught in the USA, made anatomy to be taught in the first two preclinical years and set minimum standards of anatomical dissection expected of students (Cooke et al. 2006; Miller & Weiss 2011). However, placing anatomy in the earlier years of the physiotherapy degree is said to hamper the integration and relevance of anatomical knowledge with clinical physiotherapy knowledge more prominent in the latter years (Harden et al. 1984). It remains unclear which timing is most effective for learning anatomy for physiotherapy.

There are two main threats to the traditional pedagogy: computer-based initiatives and dissolving of the epistemological justification. There has been pressure to replace face-to-face teaching sessions used in traditional cadaveric pedagogies with online courses (Reimer et al. 2013; Svirko & Mellanby 2008) and about 50% of sampled physiotherapy schools in the USA used computer-based learning (Reimer et al. 2013). The change from computer-based initiatives has been aided by that cadaveric laboratories are expensive to run (Reimer et al. 2013) and not because computer based initiatives are more effective. For example, the pass rate was 22% higher on a group of students who learnt anatomy using cadavers than on a group that used e-learning to learn anatomy (Biasutto et al. 2006). Anatomy computer-based initiatives have benefited from vast recent improvements in computer programming, types of media and the range of devices (Reimer et al. 2013) and will continue to improve. To be fair, the future anatomical learning environment for physiotherapy will most probably have a mixture of cadavers and computer based initiatives (Thomas et al. 2011) rather than having to choose between the two options.

The objectivist-dualism paradigm is the epistemological view of what anatomical knowledge learnt by students is in traditional anatomical pedagogy and is under threat. The objectivist-dualism paradigm views knowledge as rigid, non-negotiable, well-defined and requiring efficient transmission of knowledge from anatomy teachers to students as a central pillar (Brown et al. 1989; Duffy & Jonassen 1992) for students to have "an accurate knowledge of anatomy" (Raftery 2007). Knowledge is transferred as complete knowledge from the teacher or books to physiotherapy trainees (Darcus & Parry 1955), often through well-defined lectures (Russell et al. 1984). Good students are able to "reproduce information presented in lectures and textbooks" (Newstead 2004 p.97).

The anti-objectivist-dualism paradigm on the other hand finds the transmission of knowledge very problematic because of language and how previous experiences shape their interpretation of their environment and create knowledge (Biggs 1996; Glasersfeld 1990; Glasersfeld 2001; Newstead 2004). Momentum is gathering for "creat(ing) a curious, critical, open, interested, independent, creative student, scientist, teacher and leader", and the days of simply "regurgitating their knowledge during short examinations soon after the course" are gone (Ludvigsson 1999 p.127). One of the anti-objectivist-dualism paradigms emerging within the wider anatomical teaching community in health-related education and threatening the traditional anatomical pedagogy is constructivism in teaching anatomy to various health professionals e.g. to nursing students (Aversi-Ferreira et al. 2009), pre-registration healthcare students (White & Sykes 2012) and veterinary students (Van Ginneken & Vanthourout 2005). There is currently no evidence of any anti-objectivist-dualism paradigm in teaching anatomical knowledge to physiotherapy students in literature and the absence could be due to it not having been documented. The currently research might reveal epistemological paradigm shifts occurring in anatomical knowledge for physiotherapy.

2.3.2 Nature of curricula content of anatomy for physiotherapy

Determining the content to teach is far more demanding than teaching a given content (Spivey 1971). In whatever way the anatomical content for physiotherapy is classified or categorised, anatomical content involved in human movement tends to dominate the content of anatomy for physiotherapy (Mattingly & Barnes 1994; Latman & Lanier 2001; McCuskey et al. 2005;

McMeeken 2008). The anatomical knowledge of the musculoskeletal anatomy was found to be higher among physiotherapy students than among medical students (Valenza et al. 2012).

Reviews of gross anatomy courses for physiotherapy generally suffer from a weakness of being strictly limited to the views and activities occurring within universities and rarely looks at the “experiences, needs, and recommendations of clinicians working in the field” (Latman & Lanier 2001, p152). Latman & Lanier , 2001, then surveyed physiotherapists and the highest four anatomical regions recommended as a percentage of content were the back, lower limb, upper limb and neck regions with 17%, 16%, 15% and 13% respectively for the implied general undergraduate physiotherapy degree. The anatomy of the upper and lower limbs and back was confirmed as the core anatomical knowledge for physiotherapists by (Mattingly & Barnes 1994) The most recommended anatomical systems were the muscular, nervous and skeletal systems with 31%, 22% and 19% respectively (Latman & Lanier 2001). The centrality of the muscular, nervous and skeletal systems plus the human joints were reiterated by (Mattingly & Barnes 1994).

There is a feeling that the proportions of the content of the anatomy course for physiotherapists should reflect the proportions of the patient caseloads that physiotherapists carry out (Latman & Lanier 2001) and should improve the understanding of the normal and pathological conditions found in clinical physiotherapy, rather than learning of anatomical knowledge of no practical value (Darcus & Parry 1955). The common practice of aggregating physiotherapy students with other professions in anatomy classes is not been helpful because it makes it hard to create anatomical content specific for physiotherapy (Mattingly & Barnes 1994; Latman & Lanier 2001). Although the forty fields of specialisations within physiotherapy (in the old Appendix 1) show a fragmented clinical physiotherapy landscape, it seems reasonable that each field of specialisations should have its own anatomical content guidelines created within the broad musculoskeletal category.

Recommended anatomy textbooks play a significant role in giving greater clarity on anatomical knowledge (Grković et al. 2009). Although anatomy textbooks used by physiotherapy students emphasise the importance of the gross anatomy of musculoskeletal anatomy, as indicated by the booklist of **APPENDIX 26** from page **262**, they have their shortcomings. There seems to be no standard anatomical textbook with good clinical physiotherapy examples across the breath of clinical physiotherapy practice (Mattingly & Barnes 1994) and does not cover the entire breadth of anatomical knowledge for the forty different specialisations of physiotherapy indicated (in the old Appendix 1). The neuroanatomical, histological and embryological content for physiotherapy remain undocumented, beside a brief mention of having taught embryology by some (Melguizo et al. 2007; Prados et al. 2007). The lack of relevant books includes the lack of appropriate dissecting manuals for physiotherapy students and most anatomy instructors resort to designing their own in-house dissecting instructions for physiotherapy students or using anatomy textbooks for medical students (Mattingly & Barnes 1994). Medical students are fortunate in having a vast selection of clinically relevant anatomy books (Smith et al. 2005; Slaby et al. 1994; Snell 1995; Ellis 2002; Heylings et al. 2007; Sinnatamby 2011; Standring & Ellis 2005; Drake et al. 2010; Moore et al. 2013) and dissecting instructional textbooks (Clemente 2010; Kiran 2011; Loukas et al. 2012; Tank & Grant 2012). Furthermore, national anatomical societies have been forthcoming in detailing the anatomy content for medical students in Britain (McHanwell et al. 2007), USA (Leonard 1996) and Turkey (Şehirli et al. 2004), but not for physiotherapy.

The current pressures and challenges in designing an anatomy course for physiotherapists should not blinker us into forgetting that the main purpose of education is to prepare physiotherapy graduates for the future. Over the last couple of decades, the range of radiological imaging on living patients requiring intensive anatomy has grown profusely, such as computed tomography and magnetic resonance imaging (McCuskey et al. 2005) and diagnostic ultrasonography (Hides et al. 1995; Hides et al. 1998; van der Windt et al. 1999; McKiernan et al. 2010). The three dimensional computer-based technological reconstructions of these images are increasingly being used by physiotherapists. It has been argued that a physiotherapist should not just know a given anatomical content of his/her field, but the training of a new generation of physiotherapists should include skills on how to acquire future anatomical content through lifelong learning (Ludvigsson 1999), especially as the scope of physiotherapy is increasing and new fields of specialisations mature and become distinct. Such ideas challenge the traditional view of seeing anatomical content to be learnt as rigid and anatomy teacher as knowledge gate keepers, and encourages students to be knowledge gate keepers of their anatomical content.

2.3.3 Effective assessment concepts for anatomy

The assessment concepts are most likely going to be discussed in the interviews because assessment is one of the key motivators of student learning that teachers use (Case & Swanson 2002; Vorstenbosch et al. 2013) and "testing drives teaching" (Brooks & Brooks 1999 p.96). The students view assessment as the real curriculum and can often ignore the teaching if it does not match assessment (Brown & Smith 1997; Brown 2004; Ramsden 2003), and therefore, the structure and frequency of the examination will alter the study approach and strategy of the students (Smith & Mathias 2007). Assessments traditionally serve four-fold purposes: they contribute towards the final grade grades of educational certificates, motivate students to pass through effective studying, highlight the important areas to study and help identify the learning deficits of the students (Case & Swanson 2002). The assessment deliberations in this section are based on assessments of anatomy for medical students because literature into the assessment of anatomy for physiotherapy is hard to find. Assessments of anatomy for physiotherapy are expected follow the anatomy curricula for medical students because the anatomy curricula for medical students is seen as a historical benchmark for physiotherapy courses, as argued in Section 3.2 of the historical background of physiotherapy.

The literature landscape of anatomical assessments is dominated by papers focusing on types of anatomical questions (Anderson 1979; Pickering 1979; Vahalia et al. 1995; Nowinski et al. 2009; Chandratilake et al. 2011; Golda 2011; Shaibah & van der Vleuten 2013) The choice of types of questions to use should rather be seen as ingredients of a learning strategy. The most commonly used types of questions (mentioned usually in passing) in assessing physiotherapy students are Multiple Option Questions (MCQs), Short-Answer Questions (SAQs), oral examinations and practical examinations (Barclay 1994; Thomas et al. 2011).

Anatomy MCQs are the most commonly used form of anatomy assessment (Vahalia et al. 1995; Cahill & Leonard 1999; McLachlan et al. 2004; Severo & Tavares 2010; Bergman et al. 2011), with some 77% of anatomy departments in UK using MCQs (Raftery 1996). MCQs are the most time efficient assessment method in invigilating and marking (Begum 2012) and can be quickly marked and graded by computers (Krippendorf et al. 2008). Anatomy MCQs usually have simple instructions for the students to follow and have been used to make important professional grading decisions in the USA because of their high reliability (Anderson 1981; Case & Swanson 2002; Regener 2005; Ben-David 2013).

Anatomy MCQs have numerous disadvantages, however. Students can more easily copy each other during MCQ examinations (Golda 2011), although using different versions of the exam during a single sitting reduces this problem (Nilson 2010) and does not affect the results of students (Golda 2011). The other disadvantages are that MCQs encourage guessing and frequently ask pedantic questions (Anderson 1979; Pickering 1979), because examiners find it hard to make the answers less obvious (Fenderson et al. 1997). MCQs discourage creativity and are too time consuming to properly make (Begum 2012), and have encouraged the introduction of alternatives, such as the use of open-ended and Extended Matching Questions (EMQ) questions (Damjanov et al. 1995; Fenderson et al. 1997). Designing anatomy MCQs at a higher cognitive level is very challenging (Jensen et al. 2006) and most do not exceed Bloom's comprehension level 2 (Marso & Pigge 1991).

Anatomy practical examinations have a role to play in anatomy assessments. About 85% of anatomy departments in UK used pre-dissected cadaveric specimens in practical examinations, while 54% used plastic models (Gogalniceanu et al. 2009). Assessment methods that mimic the real world to foster clinical application of the knowledge are prized (Vleuten 1996), e.g. normal patients mimicked interesting abnormal clinical states (Miller 1990), but are expensive and difficult to implement. Sadly though, since 1990, anatomy departments have been switching away from practical and oral exams to written examinations, like EMQs, SAQs and SBAs, despite medical students and graduates preferring practical examinations because practical and oral examinations are far more demanding in terms of the faculty time it takes to setup and run (Case & Swanson 2002; Rowland et al. 2011). Additional scrutiny of the assessors will be required "to minimize the effects of rater harshness or leniency" in oral examinations (Case & Swanson 2002 p.11).

Most MCQs and practical based anatomy questions encourage a lower level of thinking, such as shallow rote learning, mere identification of things and examination technique strategising among students (Johnson 2002; Gogalniceanu et al. 2009; Woodford & Bancroft 2004; F. Daly 2010; Golda 2011). Anatomy is said to be heavily laden with lower thinking level content that require memorisation and learning a new vocabulary, and justified the use of MCQ assessments (Golda 2011). The exclusive use of 'identification' questions is reported to have successfully remediated failed anatomy students (Daly 2010). Even deep learners of anatomy use rote learning as part of their thinking (Pandey & Zimitat 2007; Smith 2008). However, it is not satisfactory to solely use MCQs to assess anatomy (Raftery 1996) because they fail to stimulate more critical reflective and analytic thinking (Gogalniceanu et al. 2009; F. Daly 2010; Golda 2011). Several ways have been suggested to bolster and stimulate higher levels of thinking using MCQs, such as testing comprehension, application and analysis (Woodford & Bancroft 2004; Vleuten 1996). In MCQs, the use of images could be further explored as an alternative to text based answer options are not equivalent, as image based answers require more special cognitive processing on the part of students (Vorstenbosch et al. 2013). Assessing students from a different angle from that which they were taught in could encourage higher order thinking. Cunningly changing previous years questions encourages higher order thinking because using the same questions used in the previous years encourages rote learning (Burns 2010). Combing through the previous examination and finding questions that fewer students got right and using those questions will encourage higher thinking (Burns 2010). Despite the above suggestions to improve anatomy MCQs, anatomy MCQs will still be very poor in stimulating reflective and critical lifelong learning of anatomy.

In the face of diminishing curriculum time for anatomy and growth of anatomical knowledge (Fitzgerald 1992; Collins & Given 1994; Cottam 1999; Dyer & Thorndike 2000; Heylings 2002), there is tension between two possible options for making time savings: focused assessments and global assessments. Focused assessments give greater marks and time provisions for the more relevant topics in anatomy (Case & Swanson 2002) as a teaching technique for increasing the motivation for students to learn a particular anatomical component (Wormald et al. 2009) because not all knowledge is equally useful. Time is saved by not learning and assessing the less important and less useful anatomical knowledge.

Global assessments have been praised for creating students with less knowledge deficits. In global assessments, anatomy teachers prefer to adequately sample an entire curriculum, and Case & Swanson, 2002, had to use between 175-250 SAQs to decently cover a curriculum, while Vleuten, 1996, used 250 questions. The time is saved by having a smaller overall anatomy curriculum in the first place and students learning everything in the smaller anatomy curriculum. The proposed thesis may generate a pedagogical theory that might give guidance on in how much breadth anatomical content should be assessed.

There is also no consensus in anatomy academia on the most appropriate timing of anatomy assessments. Frequent assessments are said to promote healthier enduring learning than infrequent major examinations (Case & Swanson 2002) because frequent assessments produce better knowledge retention (Wheeler & Roediger 1992) and learning occurs over a much longer period. However, frequent smaller assessments have been looked down upon because frequent tests distract the students from learning that which is not being assessed at that time and encourage the ‘tidbiting’ phenomenon (Burns 2010). The ‘tidbiting’ phenomenon is unintentionally introduced by teachers who breakdown the content they teach to ‘bite sized’ learning chunks (Newton et al. 2008). It becomes challenging when the students are asked to pull everything together (Burns 2010). Cumulative tests have been preferred rather than per topic examinations in order to encourage grasp of a larger breath of knowledge (Vleuten 1996), not just within an academic year but across all the years of the degree programme. It has been argued that the assessment of anatomy in the later clinical years, in either frequent or cumulative forms, has a greater learning impression than in earlier years (Zumwalt et al. 2007; Abu-Hijleh et al. 2005), but is at odds with most anatomy courses for physiotherapy taught in the earlier years (Latman & Lanier 2001; Mattingly & Barnes 1994).

In the absence of a clear pedagogical strategy to promote effective learning of anatomy, some anatomy teachers have been tempted to use all the assessments tools available as an insurance policy to cover any weakness that some assessment tools may have. Good anatomy assessments have been compelled to have both closed-ended, to force the students into common answers, and open-ended questions to foster unintended reflective thoughts (Rizzolo et al. 2010). A broad mix of assessment methods is recommended (Dijkstra et al. 2010) because there is no single test that can mimic clinical practice (Miller 1990). Such all-encompassing assessment approaches can be wasteful of time and other resources because some assessment tools may be useless, and worse still, can undermine the effective learning of anatomy.

2.3.4 Constraints to the teaching and learning of anatomy for physiotherapy

2.3.4.1 Diminishing curriculum time for anatomy

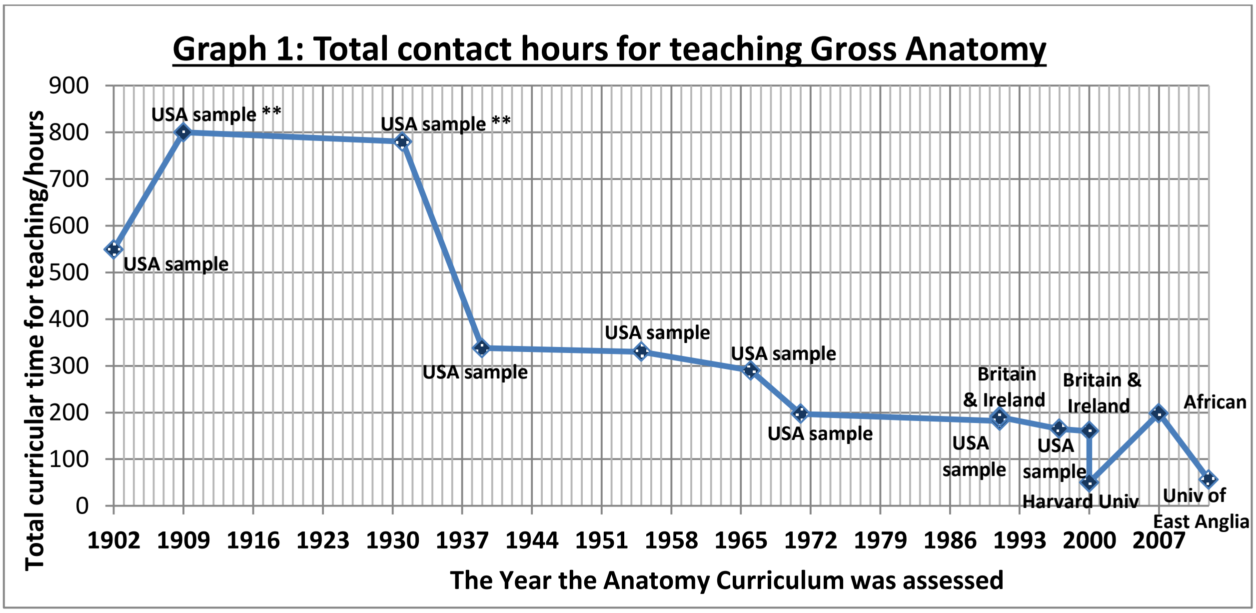
The amount of available time for teaching anatomy has had a significant bearing on how anatomy courses are designed and run (Mattingly & Barnes 1994). The time constraint discussion will begin on how pressure on time in medical schools in general affected curriculum time for anatomy for medical students and then how time limitations could be affecting anatomy for physiotherapy.

There was a feeling among medical teachers from the 1960s to the 1980s that the medical curriculum was becoming increasingly congested (curriculum hypertrophy) because of the growth of new medical and scientific knowledge into a degree programme of fixed time duration (Abrahamson 1978; Anderson & Graham 1980; Russell et al. 1984). The information that was taught through medical school and core textbooks was so great that no single student could memorise and use the knowledge (Russell et al. 1984), especially the high proportion of factual knowledge (Lowry 1992). Medical schools attempt to cope with curriculum hypertrophy by selecting the most intelligent of the applicants that are best able to cope with the punishing learning rates. The pressurised rate of learning was calculated to be at the rate of 24 facts/concepts per teaching contact hour for medical students, while students in fine arts and mathematics learnt at a third of that rate (Anderson & Graham 1980). The results of huge work overload and high factual learning is the high price medical students are paying with high rates of mental problems and they also have among the highest suicide rates of university students (Anderson & Graham 1980; Levey 2001; Goebert et al. 2009).

Anatomy for medical students was equally affected by the curricular hypertrophy affecting medical schools in general. Anatomical knowledge has grown over the last few decades, as evidenced by the exponential number of new anatomy journals and journal publications. New realms of anatomical knowledge have emerged, e.g. the invention of CT Scans (Vaughan 2008), and have encouraged computer-based three dimensional anatomical animations and software of the anatomy of patients (Anderson & Graham 1980; Grković et al. 2009).

However, there is a limit on how much can be taught or learned in a given hour and there also are a finite number of hours that can be allocated for the teaching of anatomy. Standard anatomy for medical students has four main fields: gross anatomy (about 50% and it is the anatomy you can see with the naked eye), neuroanatomy (about 20% and is the anatomy of the brain), histology (about 15% and is the anatomy of individual cells seen under a microscope) and embryology (about 15% and is the anatomy of an unborn baby). A popular gross anatomy textbook has over 7000 anatomical terms in the index section (Drake et al. 2010) and a common neuroanatomy textbook has 3000 anatomical terms (Snell 2010), and that will bring the total vocabulary of the four fields of anatomy to about 15000 words. If the 15000 words are to be taught at a very high rate of 24 facts/concepts per hour (Anderson & Graham 1980), 625 hours will be needed.

Disappointingly, the reduction in allocated time for anatomy for medical students has culminated medical schools allocating far fewer than the 625 hours, despite more curriculum time being linked to more effective learning anatomy (McKeown et al. 2003; Elizondo-Omaña et al. 2006) and more time helps students requiring remedial assistance (Elizondo-Omaña et al. 2006). The decline becomes evident when a historical graph of anatomy time for medical students over the last century is plotted on Graph 1 shown below and further details are in APPENDIX 27 on page 263.



*** Included histology, embryology and neuroanatomy*

Each of the studies on the graph were surveys (of many medical schools in a particular regions except for Harvard University (Dyer & Thorndike 2000) and the University of East Anglia where I taught) and the averages of the total hours are indicated. Curricular time has been in a steady decline from about the early 1900s and steadied to about 200 hours per annum in the 1980s and 1990s, while the medical schools of the University of East Anglia and Harvard University (Dyer & Thorndike 2000) have dropped to about 50 hours per annum. Time reductions were made by achieving closer integration of inter-disciplinary knowledge, sacrificing lecture time for clinical attachments in hospitals, allocation of more faculty time for research and reduction in anatomical detail (Eldred & Eldred 1961).

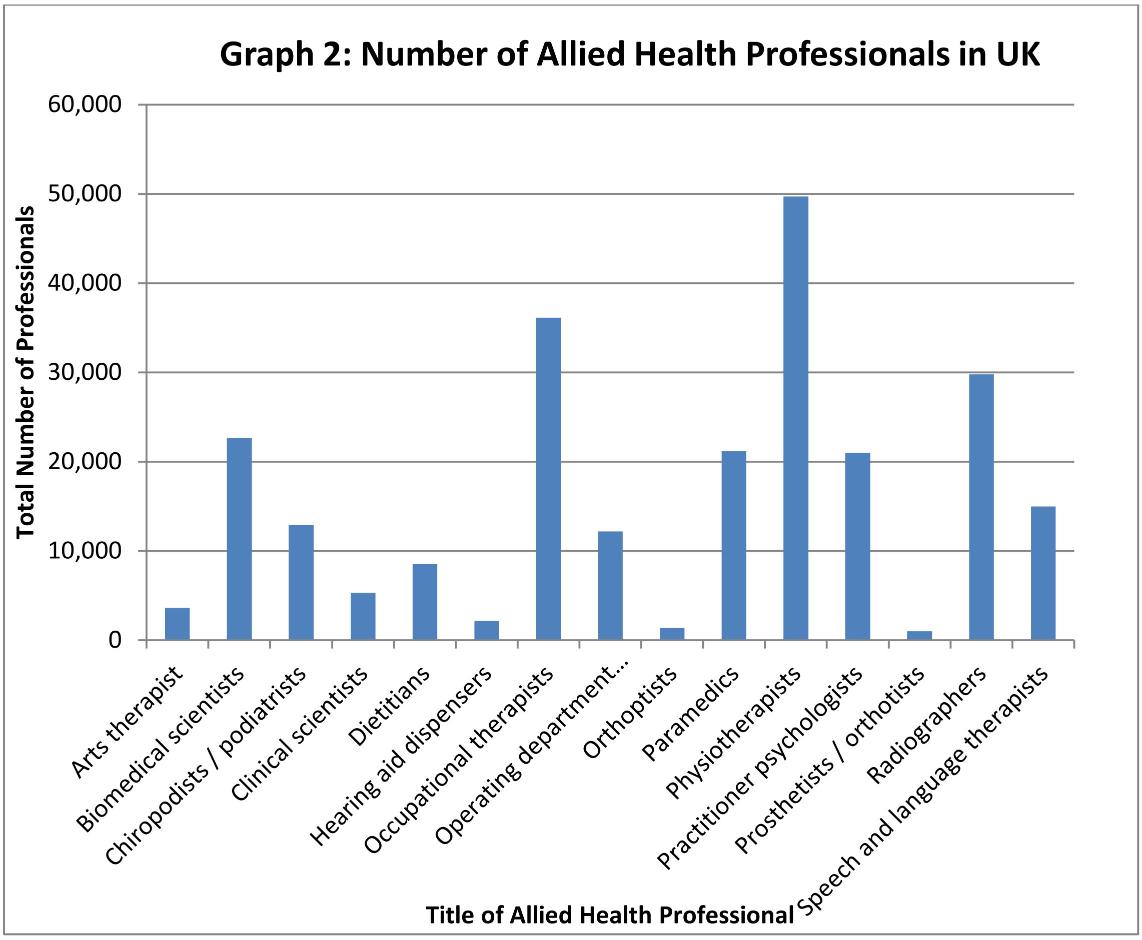
The decline in available hours for anatomy have made low density lectures more appealing for efficient learning and retention of knowledge (Aiken et al. 1975; Russell et al. 1984). The General Medical Council (GMC) that regulates medical schools in the UK has helped reduce the amount of teaching and mandated that all medical schools should make reductions in teaching time (including anatomy) by one third (Gogalniceanu et al. 2009; Rubin 2009). Although curricular time has been reduced, there are indications that student learning is being offloaded to the private study time of the students in the evenings and weekends under the guise of offloading the traditional teaching role of the teacher to the student and preparing a student to teach him/herself (Maddison 1978). Some medical students are consequently being forced to spend about 80 hours a week of learning (Goebert et al. 2009).

Although literature on delivering increased anatomical knowledge for physiotherapy on dwindling curricular time is hard to find, a rare exception being Mattingly & Barnes, 1994 , there are historical benchmarking reasons indicated in Section 2.2 to believe that the trends in anatomy for physiotherapy follow the trends in anatomy for medical students. There are strong indications from the total curricular time available for all the physiotherapy modules (Crosbie et al. 2002) that the maximum amount of time available for anatomy for physiotherapy students is probably around 100 hours. Poor oversight of the time spent learning anatomy can create an unhealthy and stressful learning environment for students. The significant curricula time constraints is potentially a factor in crafting an effective pedagogical theory to guide the learning of anatomy among physiotherapy students, that is lacking in literature and might be clarified by the proposed thesis.

A common role of all national physiotherapy boards is to set professional standards for physiotherapists and to accredit physiotherapy degree programmes. In the UK, the physiotherapy board legally mandated with the authority is the Health and Care Professions

Council (HCPC-Regulation 2015) and has about 50000 registered physiotherapists, the largest allied health professional group, as shown in Graph 2 (HCPC-Registrants 2015),

2.3.4.2 Curricula influence from national physiotherapy regulatory boards



One of the biggest curricula changes over the last century, pushed for by professional physiotherapy boards, has been the change from structure and process-based learning to competency-based learning (Carraccio et al. 2002), also referred to as proficiency-based learning in the UK by the HCPC (HCPC 2013). A 'competency' is a "a complex set of behaviours built on the components of knowledge, skills, attitudes, and 'competence' as personal ability" and involves bringing together of many different subject objectives (Carraccio et al. 2002 p.262). The wide ranging curricular changes of competency-based learning is indicated in Table 1 below from Carraccio et al. 2002 p.262.

Table 1: A Comparison of the elements of structure- and process-based versus competency-based educational programs

	Educational Program	
Variable	**Structure and Process-based**	**Competency-based**
Driving force for curriculum	Content—knowledge acquisition	Outcome—knowledge application
Driving force for process	Teacher	Learner
Path of learning	Hierarchical (teacher ⇒ student)	Non-hierarchical (teacher ⇔ student)
Responsibility for content	Teacher	Student and teacher
Goal of educational encounter	Knowledge acquisition	Knowledge application
Typical assessment tool	Single subjective measure	Multiple objective measures
Assessment tool	Proxy	Authentic (mimics real tasks of profession)
Setting for evaluation	Removed (gestalt)	''In the trenches'' (direct observation)
Evaluation	Norm-referenced	Criterion-referenced
Timing of assessment	Emphasis on summative	Emphasis on formative
Program completion	Fixed time	Variable time

The approach strategy for designing competencies is well known. Firstly, the competencies have to be identified, then have their components teased out and the assessments for the competencies crafted (Carraccio et al. 2002). Competencies can be identified using the Delphi technique (with various permutations); from groups of experts, task analysis of clinicians at work, surveys on critical incidences of clinicians, studies of errors in practice, analysis' of existing curricula and surveys of recent graduates or practitioner surveys (Spivey 1971; McGaghie et al. 1978; Dunn et al. 1985; Harden 1986). The competencies are set at 'minimally accepted' standards that should not compromise high standards (Spivey 1971).

The main problem with competency-based learning and assessment is that it was mainly designed for clinical subjects, and has no meaningful relevancy for the teaching, learning and assessment of basic sciences, such as anatomy. There is no evidence in literature of competency-based anatomy curricula run by anatomy departments. It makes obvious sense that assessment in competency-based curricula should also change from discipline-led to integrated assessment (Hudson & Tonkin 2004) and move from norm-referenced measures to criterion-referenced measures (Brown & McCleary 1973). Moving from norm-referencing to criterion referencing measures is necessitated because criterion-referenced measures compare competency to well-known performances (Brown & McCleary 1973). However, almost all the anatomy examinations reviewed in literature are process-based, discipline led and norm-referenced, as evidenced by that three-quarters of anatomy examinations in the UK being process-based MCQs (McLachlan et al. 2004; Bergman et al. 2011; Severo & Tavares 2010). While the UK physiotherapy registration boards, HCPC, has moved towards compulsory competency-based learning (HCPC 2013), the anatomy curricula for physiotherapy in literature are still operating under the traditional structure and process-based learning (Latman & Lanier 2001).

Central to the concept of competency-based teaching and learning is the idea of integrated learning, which moves away from discipline-led teaching to integrated teaching (Shafi et al. 2010), because integrated learning is said to be superior (Papa & Harasym 1999). Learning anatomy in integrated pedagogy then becomes just one facet of the multi facets of knowledge students of physiotherapy should learn and be able to apply in clinical practice to prove professional competence (Mattingly & Barnes 1994; Armstrong & Rosser 1996). Integration between the basic sciences (like anatomy and physiology), and between basic sciences and clinical sciences has been advocated to be very helpful in recalling information (Harden et al. 1984). Among some of the teaching techniques used to integrate disciplines include awareness, harmonisation, temporal co-ordination, sharing, complementary, multi-disciplinary, horizontal and vertical integration, inter-disciplinary and trans-disciplinary techniques (Maddison 1978; Harden 2000; Malik & Malik 2011).

Clarity by physiotherapy professional boards on how anatomy is to be taught is very poor and frequently the guidance does not exceed one sentence, with individual universities expected to thresh out the details of the basic sciences themselves. For example, the word ‘anatomy’ only appears once in each of the well-respected Standards of Proficiency for Physiotherapist documents (HCPC 2013). The HCPC, like other physiotherapy professional boards worldwide, appear to have taken their cue from medical professional boards who hold a similar stance of having no explicit details of the recommended anatomy curricula, such as the Scottish Deans' Medical Curriculum Group (Scottish-Deans 2015), General Medical Council (GMC) of the United Kingdom (Gogalniceanu et al. 2009; Rubin 2009) and the Turkish medical curriculum (Kemahli et al. 2004).

Competencies present another dilemma for anatomical teaching by relying on tacit knowledge. Competences of experienced clinicians tend to rely on tacit knowledge for their day-to-day practice of medicine (Michael & Polanyi 1964). Tacit knowledge is what we know but find it hard to describe or explain, such as the rule-of-thumb and intuition. Anatomy is largely in the realm of explicit knowledge and how that knowledge will end up being tacit knowledge is poorly understood. The assessment of tacit knowledge is even harder and how to untangle basic sciences used to build tacit knowledge is incredibly complex. Doubts exist on whether explicit knowledge could be taught and examined through the means of tacit knowledge. Most of the degree programmes, outside professional courses in universities, tend to run on process-based learning and use norm-based criterion assessments. Universities may struggle to accommodate the administrative, teaching and assessment structures needed for competency-based learning based on tacit knowledge.

One of the problems of using competencies and sub-competencies is that different terminology is used among the different national physiotherapy boards (Carraccio et al. 2002) and often some of the competencies are essentially different among different national physiotherapy boards. It becomes a challenge for anatomy teachers for physiotherapy to translate the different and differently termed competencies into practical anatomy courses. There is no reference in literature linking competencies to the teaching of anatomy for physiotherapy. Furthermore, the preparation of competencies assumes that the clinician initially assessed has no deficiencies (Spivey 1971) and competency-based learning borders on going back to behaviourism, where the thought processes are not considered but the outward appearance. Competencies could potentially be discussed in the research interviews and a deep understanding of competency-based learning will better prepare the author for real-time analysis of the interview information.

2.3.5 Discussion of the literature review

There is a larger body of knowledge in pedagogical literature for anatomy for medical students than for physiotherapy students and the transferability of the curricula concepts to the anatomy curricula for physiotherapy are not always clear and cannot be guaranteed. Most of the pedagogic anatomical concepts for anatomy for medical students have been written by anatomists with no practical exposure to clinical physiotherapy. For example, virtually all of the literature on assessment of anatomy in Section 3.3.4 comes from assessment of anatomy in medical students.

From my 15 years of experience in teaching anatomy, there are indications that there are still other curriculum concepts that are being used that are not available in literature. For example, at the University of Birmingham, pre-registration MSc Physiotherapy students studying anatomy have no lectures, tutorials or examinations in anatomy from the time they are admitted into the degree programme to graduation. The students are trusted by the lecturers that they will learn anatomy to a satisfactory level themselves and it will be interesting to understand the pedagogic concepts underpinning such learning of anatomy. There is no reference in literature of such pedagogic approaches into learning anatomy for physiotherapy and is an indication of how the anatomical concepts for physiotherapy are poorly understood.

Whilst, some concepts outlined in literature are driven by philosophical convictions, such as competency-based educational systems, the current thesis hopes to generate theoretical concepts governing the learning of anatomy that are grounded in the current educational practice of anatomists with physiotherapy credentials. Most of the recommended curriculum concepts for anatomy have advantages and disadvantages and the study hopes to delve deeper into the interplay of pedagogic concepts of anatomy for physiotherapy and how they are are interlinked.

The literature review has a number of strengths and weaknesses. The literature review has demonstrated a very extensive review of literature ranging from the history of physiotherapy, and current pedagogical review to the teaching of anatomy for physiotherapy, anatomical assessments in general and some of the influences from national physiotherapy boards. The literature review has been of great service in preparing the author to better engage with some of the major concepts of future pedagogical discussions with the interviewees of the proposed thesis. The author was especially profoundly aware of the implicit nature of educational concepts governing the teaching and learning of anatomy and having knowledge of the concepts is a great asset and will be of use in the educational career of the author. The author had to apprise himself of the various methodologies within the numerous paper reviews to better understand them. A forte of the literature review was the almost entire use of primary literature sources and use of the most influential papers. Weaker and poorer quality interviews would result if the author was not knowledgeable in the background complex pedagogical concepts prior to the interviews. The author made a good attempt of reducing technical jargon in the literature review from both fields of physiotherapy and anatomy. For example the Old Appendix 1 used and explained technical physiotherapy terms used.

There were a number of weaknesses with the literature review. A too specific literature review has a danger of pre-empting a grounded methodology, is not advised and goes against the spirit of grounded methodology (Glaser & Strauss 1967; Glaser 1998; Glaser 2002; Charmaz 2006; Nathaniel 2006; Holton 2007). The literature review was broader because the direction to be taken by the theory formed as a result of the analysis of the interviews and grounded methodology is not precisely known. There is a danger that some of the concepts discussed in the literature review or personal opinions of the author might permeate through the analysis of the interview transcripts, rather than allowing the concepts to emerge from the interview transcripts because of having conducted the literature review before the interviews. The author will take care to allow the concepts to emerge from the interview transcripts and will keep a record of the transcripts and put direct quotations where possible. Further safeguards to avoid contamination of the interview findings will come in the form of the author writing his personal opinion before the interviews on what he thinks are effective pedagogical concepts for learning anatomy. The personal opinions will be compared to the research findings to determine the potential degree of conceptual contamination.

Few of the full articles could not be obtained and the author just had to use the abstract and this has been indicated in the reference section. The literature on anatomy for physiotherapy written within the last 15 years was minimal, especially for the UK, and I had to extend the literature search to beyond 15 years and had to lean more on pedagogical concepts on anatomy for physiotherapy from the USA. A more detailed exploration of the background history of anatomy in physiotherapy could have been made because there were extensive historical events occurring over a period of 200 years involving numerous countries, but fell outside the scope of the proposed thesis. Only the physiotherapy history of the UK and not of all countries were explored because of time and scope limitation reasons (Öhman 2001). The greatest emphasis was given to the UK because the research participants will be selected from the UK, as indicated in Section 2.3 in the Old Appendix 7: Proposed Research Design, Methodology and Methods.

3 Summary of the proposed Research Design

The epistemological, methodological and method concerns and deliberations of the proposed research design were critically explored in an earlier successfully passed Level 8 module of the EdD programme, and below is a condensed summary of the full proposed research method presented in APPENDIX 28 from page 264. The proposed methodology would like to find the 'concepts' that anatomy teachers use to ensure effective learning of anatomy by physiotherapy students. The anatomical knowledge learnt will help the physiotherapy students to effectively examine and treat patients in their future career.

The author is hoping to use in-depth open interviews with about 15 anatomy lecturers (ideally until data saturation) from among the 37 universities offering the pre-registration physiotherapy degree programmes in the UK (HCPC, 2015), who are registered physiotherapists with at least eight years of anatomy teaching experience. Non-physiotherapy anatomy teachers will be unsuitable because they differ significantly from physiotherapy teachers on what anatomical content is appropriate (Mattingly & Barnes 1994). The contact details of the participating Physiotherapy lecturers teaching anatomy will be obtained in three phases: internet-based search, snowballing phase and a pre-interview (closed questionnaire) survey. Analysis of the pre-interview survey will enable the author to select participants with the richest knowledge of the 'key concepts' involved 'in running an effective and modern anatomy curriculum for physiotherapy'. Open interviews will be used on subjects fulfilling the inclusion criteria and the interviews will be recorded verbally and then transcribed in preparation for analysis with Grounded Theory. Open coding will be used to allow the 'key concepts' to emerge and will be translated into a theory using Grounded Theory.

4 Conclusion of the literature review

The four British women founders of physiotherapy, contemporaries of Florence Nightingale, performed a remarkable task of raising physiotherapy from almost nothing in 1894/1895, a good quarter of a century before women could vote in Britain (Barclay 1994), to where Physiotherapy now boasts over forty societies in the UK focusing on various specialised areas of physiotherapy (CSP-Professional-Networks 2013).
Theory for pedagogical innovation for teaching and learning physiotherapy remains weak (Broberg et al. 2003), especially anatomy. The popular traditional anatomical pedagogy is no longer sustainable because the scope of physiotherapy practice has grown tremendously over the last 30 years (Mattingly & Barnes 1994; Latman & Lanier 2001). The basis for determining

the content for anatomy for physiotherapy is not clear, especially in the face of declining curriculum time for anatomy in general (Mattingly & Barnes 1994). There seems to be no pedagogical strategy or guidance connecting anatomical assessment to teaching and assessment and this risks generating confusion among teachers and students. There is no evidence in literature showing that competency-based learning being pushed by the physiotherapy professional boards has been implemented by physiotherapy schools. The literature review has explored the weaknesses of current strategies into learning anatomy and hopes to fill the void with a new theory linking effective pedagogical concepts to the proposed methodology in APPENDIX 28 from page 264.

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Appendix 30: Completed RDC1 Form

Staffordshire UNIVERSITY

RESEARCH DEGREES SUB-COMMITTEE

APPLICATION TO REGISTER FOR A RESEARCH DEGREE

Submitted by the School of.... *Education in the Faculty of Business, Education and Law*

Applicants and their supervisors should consult the University's Regulations for the award of Research Degrees before completing this form. Copies may be obtained from the University's website or the Research Degrees Administrator.

Name of Candidate	Mr Hope Gangata
Research Award (delete as appropriate)	Professional Doctorate – Doctorate in Education Wider Participation in Learning (EdD)
Mode of Study (full time or part time)	Part-time
Title of the Research Project	An investigation of the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study
Home Address	XX XXXXXX Grove, Birmingham, BXX XXX, UK
Correspondence Address (if different)	Same
Daytime Tel No	079XXXXXXXX
Email address	hopegata@yahoo.co.uk g035382e@student.staffs.ac.uk
Date of enrolment on award	Sept 2014
Start date requested for research degree registration purposes.	September 2015
Expected average weekly commitment to the research programme	20 hours
Expected submission date for the thesis	December 2016
Intellectual Property Rights	No
Source of Financial Support	Self-funding
Details of Higher Education qualifications gained Institution attended, dates, award,	**Doctorate in Education degree** (in Anatomy) Module 1 - Educational Research: Philosophy and Practice. Entitled: *A research approach for a proposed study entitled: 'The proposed theory based on key concepts involved in running an effective and modern anatomy curricula for*

classification, etc. If Masters award included a dissertation research project provide <u>title</u> and <u>word length.</u>	*physiotherapy practice. 9000 words at* Level 8 of the National Qualifications Framework (Passed) <u>Module 2 - Educational Policy: Theory and Practice.</u> Assignment entitled: *The dynamics of the policies of donated cadavers for anatomical teaching: The modified theory of the Path-of least-resistance. 9000 words at* Level 8 of the National Qualifications Framework (Passed) Published (Gangata, 2015) <u>Module 3 - Educational Management, Leadership and Administration.</u> Assignment entitled: *A proposed normative and rational ambiguous leadership theory based on anatomical research supervision: The 'Repair-Workshop Theory'. 9000 words at* Level 8 of the National Qualifications Framework (Passed) Published (Gangata, 2016) **Master of Arts in Higher Education Practice** degree (From Sept 2009 to July 2012) University of East Anglia Dissertation entitled: *"A preparatory framework for developing a theory on how anatomy is learnt" 14 000 words at* Level 7 of the National Qualifications Framework (Graduated) **Masters in Medicine in Anatomy degree** (April 2006 to March 2008, 2-yr fulltime by Dissertation only) University of Cape Town, Cape Town, South Africa Dissertation entitled: Parameters related to the equinus ankle in ambulatory children with cerebral palsy: an investigation of the differences between children with the diplegic and hemiplegic subtypes. 40 000 words *at* Level 7 of the National Qualifications Framework (Graduated)
Training and experience (include details of activities undertaken [with dates] relevant to this application and any research or other <u>relevant conference papers, articles,</u> books etc which have been published)	**<u>Published Journal Papers</u>** New additions Gangata H, 2016. The repair-workshop theory: supervising anatomical research. Anatomy Journal of Africa. 5 (1): 631-639. Gangata H, 2015. A proposed worldwide classification system for ways of sourcing of anatomical cadavers that is progressive towards the use of donated anatomical cadavers. Edorium Journal Anatomy and Embryology. 2:20–25. Gangata H, Ndou R, Jooste S and Louw G. 2012. The manual tests that can elicit the strongest responses from the palmaris longus muscle. Journal of Experimental and Clinical Anatomy, 11(1). Gangata H, Ntaba P, Akol P and Louw G. 2010. The reliance on unclaimed cadavers for anatomical teaching by Medical Schools in Africa. American Journal of Anatomical Science Education. Jul-Aug;3(4):174-83. Impact Factor 2.976 Ndou R, Gangata H, Mitchell B, Ngcongo T, and Louw G. 2010. The frequency of absence of palmaris longus in a South African population of Mixed Race. Clinical Anatomy. May;23(4):437-42. Impact Factor 1.348 Gangata H, Ndou R and Louw G. 2010. The contribution of the palmaris longus muscle to the strength of thumb abduction. Clinical Anatomy. May;23(4):431-6. Impact Factor 1.348 Gangata H. 2010. A mental hook for learning the three-

	dimensional anatomy of the sphenoid bone: An angelic resemblance. British Journal of Oral & Maxillofacial Surgery. Jul;48(5):e27-8. Impact Factor 1.890 Gangata H. 2010. Descriptions of anatomical structures using everyday objects may disadvantage students from developing countries. Anatomical Science Education. Jan-Feb;3(1):52. Impact Factor 2.976 Unger M, Jelsma J, Gangata H, Louw G (2009): The reliability of Ultra-sound measurements of the abdominal muscles in typically developing children. SA Journal of Physiotherapy 65:3:22-26 Gangata H. 2009. A convenient three dimensional model to teach the arterial supply of the brainstem. Artery Research 3(2): 89-90. Gangata H. 2009. Inaccurate formula for determining the volume of a muscle in vivo. European Journal of Applied Physiology Jun;106(3):479 Impact Factor 2.214 Gangata H. 2009. A 3-dimensional anatomy model of the heart organ using a gloved hand. British Journal of Cardiology 16:44–46. Gangata H. 2009. The clinical surface anatomy anomalies of the palmaris longus muscle in the Black African population of Zimbabwe and a proposed new testing technique. Clinical Anatomy 22(2):230-5. Impact Factor 1.348 Gangata H. 2008. A 3-dimensional anatomy model of the liver organ using a gloved hand. Liver International Journal 28 (4): 532-533. Impact Factor 3.84 Gangata H. 2008. An innovative approach to supplement the teaching of the spatial gross anatomy relationships of muscles to undergraduates in Health Sciences. Clinical Anatomy 21 (4): 339-347. Impact Factor 1.348 **Books** Gangata H. 2012. 'The Fattened Lions on the Educational Odyssey' The Autobiography of Hope Gangata (A case for raising aspirations and widening access to higher education). Diadem Books. ISBN-13: 978-1908026477 **Published Abstract** Gangata H, Agass J, Kupa T, Morgan S, Saha G. 2012. What assessment features of anatomical computer-aided learning packages were preferred by students? Clinical Anatomy 25 (6): 798-812 Gangata H, Jelsma J and Louw G. 2009. An investigation into the differences in parameters related to the Equinus ankle between children with cerebral palsy who present with spastic diplegia and with spastic hemiplegia. Clinical Anatomy 22:277. Impact Factor 1.348 Gangata H, Ndou R and Louw G. 2009. An investigation into the contribution of the palmaris longus muscle to the strength of thumb abduction. Clinical Anatomy 22:275. Impact Factor 1.348 Gangata H. 2008. An innovative approach to supplement the teaching of the spatial gross anatomy relationships of

	muscles to undergraduates in Health Sciences. Clinical Anatomy 21 (4): 358. Impact Factor 1.348 Gangata H. 2008. The clinical surface anatomy anomalies of the Palmaris Longus muscle in the Black African population of Zimbabwe and a proposed new testing technique. Clinical Anatomy 21 (4): 359. Impact Factor 1.348 Gangata H. 2008. Three-dimensional anatomy models of the heart and liver organs using a gloved hand. Clinical Anatomy 21 (4): 362. Impact Factor 1.348 **<u>Presentations at Conferences</u>** Gangata H, Agass J, Kupa T, Morgan S, Saha G. 2011. What assessment features of anatomical computer-aided learning packages were preferred by students? Winter Meeting of the Anatomical Society, the British Society of Clinical Anatomists and the Institute of Anatomical Sciences, Cardiff, Wales Gangata H, Ntaba P, Akol P and Louw G. Aug 16-19, 2009. Cadaver Sources in Africa: An Ethnical and Religious investigation. 17th International Congress of the Federation of Associations of Anatomists (17th IFAA). Cape Town, South Africa Ndou R, Gangata H and Louw G. Aug 16-19, 2009. The frequency of absence of the palmaris longus muscle among the South African Coloureds. 17th International Congress of the Federation of Associations of Anatomists (17th IFAA). Cape Town, South Africa Gangata H. Aug 16-19, 2009. Palmaris Longus muscle: Recent clinical advances. 17th IFAA. Cape Town, South Africa Gangata H. Aug 16-19, 2009. The resemblance of the sphenoid bone to the Isaiah angel. 17th IFAA. Cape Town, South Africa Gangata H, Jelsma J and Louw G. 2008. An investigation into the differences in parameters related to the Equinus ankle between children with cerebral palsy who present with spastic diplegia and with spastic hemiplegia. 38th Anatomical Society of Southern Africa (ASSA) conference, Magaliesburg, South Africa. Gangata H. 2007. An innovative approach to supplement the teaching of the spatial gross anatomy relationships of muscles to undergraduates in Health Sciences. 37th ASSA conference, Magaliesburg, South Africa. Gangata H. 2007. The clinical surface anatomy anomalies of the Palmaris Longus muscle in the Black African population of Zimbabwe and a proposed new testing technique. 37th ASSA, Magaliesburg, South Africa. Gangata H. 2007. Three-dimensional anatomy models of the heart and liver organs using a gloved hand. 37th Anatomical Society of Southern Africa conference, in Magaliesburg, South Africa. Gangata H. 2005. The interconnections of the hypoglossal nuclei to the other cranial nerves involved in speech. 'International Brain Research Organisation' workshop on research techniques. Morocco.

Will your programme of research be largely conducted at the University?	Yes
Collaborating Establishment	N/A

- **RESEARCH TRAINING AND RELATED STUDIES**

Please give details below of when you completed, or when you expect to complete the University Postgraduate Certificate in Research Methods course.

Also provide details of any additional research training and how this has prepared, or will prepare you for the research project.

If you believe your previous education and experience would permit you to claim a full exemption from the PgCRM, you must complete the Exemption Form (available from your Faculty research degrees administrators) and attach it to this RDC01. (Partial exemptions are handled internally to the PgCRM through the learning contract.)

I passed the below Doctorate in Education degree (in Anatomy) module

Module 1 - Educational Research: Philosophy and Practice. Entitled: *"A research approach for a proposed study entitled: The proposed theory based on key concepts involved in running an effective and modern anatomy curricula for physiotherapy practice. 9000 words at* Level 8 of the National Qualifications Framework. The Module Descriptors are listed below.

ED60272: Educational research: philosophy and practice

Academic Year:	2014/5
Owning Department/School:	Department of Education
Credits:	18
Level:	Doctoral (FHEQ level 8)
Period:	Modular (no specific semester)
Assessment Summary:	CW 100%
Assessment Detail:	• Assignment (CW 100%)
Supplementary Assessment:	Like-for-like reassessment (where allowed by programme regulations)
Requisites:	
Description:	**Aims:** The unit's aims are to provide participants with a critical understanding of: (i) the philosophical issues concerned with the limits and possibilities of educational research as a means of gaining knowledge and understanding of educational systems and processes; (ii) those principles, theories, techniques and standards of judgement associated with the collection, analysis and interpretation of quantitative data; and a critical understanding of the strengths and weaknesses of such processes; (iii) those principles, theories, techniques and standards of judgement associated with the collection, analysis and interpretation of qualitative data, and a critical understanding of the strengths and weaknesses of such processes;

(iv) the different forms of representation which can be used in the generation of educational theories;
(v) when it is appropriate to employ particular methodologies and methods, to collect certain types of data, and use particular modes of analysis.

Learning Outcomes:
As a result of the development of that critical understanding, participants will be able to:
(i) understand and evaluate the approaches to research described in published papers, and be able to form critical judgements about the worth and effectiveness of such research;
(ii) make appropriate judgements about which approaches to educational research they can most appropriately use in their own research enquiries so as to meet their own research objectives;
(iii) carry through those enquiries efficiently and effectively, and thus meet the requirements of the EdD degree as a whole.

Skills:
(i) Apply a systematic and coherent approach to critical analysis, evaluation and synthesis of ideas, information and issues that is well-grounded in existing educational research and literature (intellectual skill)
(ii) Identify and address complex and/or emerging issues in education and make informed judgements in the absence of complete or consistent information (professional/ practical skill)
(iii) Continually develop and enhance participants' own practice through critical reflection and practical action with the aim of improving conditions for the development of all involved in the educational enterprise (professional/ practical skill)
(iv) Recognise and judge the value, relevance and reliability of information drawn from multiple sources (theory, research, policy and emerging practice) and interpret that information in ways that cultivate improvements to practical activity and decision-making (professional/ practical skill)
(v) Continually develop and enhance participants' own practice and influence the practice of others through critical reflection and practical action with the aim of improving conditions for the development of all involved in the educational enterprise (professional/ practical skill)
(vi) Use networked learning technologies as a means of developing one's own professional practice and scholarship (professional/ practical skill).

Content:
Section 1: The Philosophy of Educational Research
(i) Positivism and Empiricism in the natural and social sciences: Foundationalism and its problems.
(ii) Post-empiricist theories of natural and social sciences: the problems of Naturalism: Judgmental relativism and its problems. Critical and post-modern theories of research enquiry.
(iii) The links between the philosophy of research methodologies and research methods - problem-based methodologies.
Section 2: Quantitative Approaches
(i) An introduction to the principles and techniques of quantitative data analysis
(ii) Quantitative literacy: the limits and possibilities of statistical enquiry.
(iii) The critical reading of quantitative research.
Section 3: Qualitative Approaches
(i) An introduction to the various qualitative techniques including: interviewing, grounded theory, ethnography, participantt observation, analytical induction, action research, and life histories.
(ii) Qualitative literacy: the limits and possibilities of qualitative enquiry.
(iii) The critical reading of qualitative research.
Section 4: The Application of Research Methodologies and Methods
(i) Research ethics.

	(ii) When to apply either quantitative or qualitative techniques and why.
Programme availability:	**ED60272 is Compulsory on the following programmes:** **Department of Education** • RHED-AFD01 : Doctor of Education • RHED-APD01 : Doctor of Education

- **FACILITIES AVAILABLE FOR THE INVESTIGATION** (including funding and location).

  - The research will involve interviewing participants at different universities.

  Please indicate the proportion of time to be spent working at the University and any Collaborating Establishment. If it is proposed that part of your programme of work will take place outside Staffordshire University, please specify the facilities available to you at the partner or collaborating establishment.

NB: In the case of any collaborative work the RDC1 must be accompanied by a letter confirming the collaboration and the availability of facilities/resources in support of the project. In addition, the student and his supervisors must give details of contingency measures to deal with possible changes of the collaboration which could have a detrimental impact on the research programme (for example if the Collaborating Establishment ceases operating, decides to withdraw its support, changes its project requirements, etc). The statement of contingency measures must show that successful completion of the programme is not coupled tightly to the collaboration.

- **ETHICS**

I/We confirm that ethical implications concerned with the proposed research programme have been considered by the Candidate and the Supervision Team and where appropriate, a full application to an Ethics Committee (eg Faculty, University, NHS) has or will be made when the complete details of the research programme are known:

Not Applicable

Applicable - approved - provide details of application(s) and outcomes(s) and append documents

Applicable - to be approved - provide details

The research proposal was approved by the Ethics Committee of the Faculty of Business, Education and Law on the 9th of July 2015 and by my Research Supervisor on the 5th of August 2015. The copies of the approval letters are in the Old Appendix 8 and 9 of the Research Proposal.

Signatures:

Candidate: …[redacted]… Date: … 17 Aug 2015………….

Principal Supervisor: …[redacted]… Date: …01.08.15…………………

- **CONFIDENTIALITY**

  Is permission sought for the thesis to be kept confidential? NO
  (Maximum period two years after submission)

  If permission is sought, written justification must accompany the application.

RISK ASSESSMENT SUMMARY

The Principal Supervisor should identify areas of work in the following risk categories:

A = Those where work may <u>not</u> be undertaken without <u>direct</u> Supervision;

B = Those where work may not be started without Supervisor's advice and approval;

C = Those with risks (other than categories A & B) where extra care must be observed, but where it is considered that workers are adequately trained and competent in the procedures involved;

D = Those where the risks are insignificant and carry no special supervision considerations.

The nature of the risks should be defined, ie toxicity, explosion, high-voltage, lasers, flammability etc.

Instructions and advice should include the method of work and the safeguards to be used.

The person who is to supervise A and B risks should be identified

Nature and Method of Work	Hazards/Risks	Safeguards	Category Assigned
Questionnaires and interviews with professional physiotherapists.	None anticipated	None necessary beyond routine ethical procedures.	D

<u>Signatures:</u>

Candidate: ……[redacted]… Date: …17 Aug 2015…….

Principal Supervisor: ……[redacted]… Date: …01.08.15…………..

- **SUPERVISION OF THE PROGRAMME OF WORK**

INTERNAL SUPERVISORS - a Supervisors CV proforma must be submitted for each supervisor (available from the Research Awards Administrator). Other forms of C.V. will **NOT** be accepted.

Name of Principal Supervisor	Dr Katy Vigurs			
Department and Faculty	School of Education in the Faculty of Business, Education and Law			
Email address	k.vigurs@staffs.ac.uk			
Area(s) of subject expertise	Educational Research, Higher Education Pedagogies, Professional Education, Qualitative Research Design.			
Number of registered research degree candidates currently supervised	MPhil		PhD EdD	4 13
Number of candidates previously supervised to successful completion	MPhil		PhD EdD	1 1
Undertaken the University's Research Supervisors Training Module, and actively researching	YES			2010

Name of Secondary Supervisor	Dr Cheryl Bolton			
Department and Faculty	School of Education in the Faculty of Business, Education and Law			
Email address	c.bolton@staffs.ac.uk			
Area(s) of subject expertise	Teacher Development in Post-Compulsory Education, Qualitative Research Methodologies, Bourdieu theory.			
Number of registered research degree candidates currently supervised	MPhil		PhD EdD	5 10
Number of candidates previously supervised to successful completion	MPhil		PhD	0
Undertaken the University's Research Supervisors Training Module, and actively researching	IN PROGRESS			

EXTERNAL SUPERVISOR/ADVISER (if appropriate)

If the bulk of the programme of research is to be conducted outside Staffordshire University, candidates must have a supervisor based at the institution or body at which the research will be carried out.

Please include details of External Supervisors/Advisers below **-** a Supervisors CV proforma must be submitted for each supervisor/adviser (available from the Research Awards Administrator). Other forms of C.V. will **NOT** be accepted.

STATEMENT BY THE APPLICANT

On the basis of the proposals given in this application, I wish to apply for registration for the degree of:
- Research Project for the Doctorate in Education Wider Participation in Learning (EdD)

I confirm that all the information given is correct.

I understand that, except with the specific permission of the Research Degrees Committee, I may not, during the period of my registration, be a candidate for another research award.
I understand that, except with the specific permission of the Research Degrees Committee, I must write and defend my thesis in English.

Signed ...Hope Gangata....[redacted].............. Date 17 August 2015........

RECOMMENDATION BY THE SUPERVISORS

We support this application and believe that the applicant has the potential to successfully complete the programme of work proposed within the University's maximum registration period.

We recommend that the applicant be registered as a candidate for a research degree.

Signed ......Dr Katy Vigurs…………………………… Date 01.08.15.....................

Signed ....Dr Cheryl Bolton.......................... Date 17/8/15………………………

FACULTY/SCHOOL SUPPORT

I support this application and confirm the Faculty will ensure the necessary resources are made available for the duration of the project.

Signed .... Print Name…………………………… Date ....

(Faculty/School Director of Research & Enterprise)

- **PROPOSED PLAN OF WORK**

  You must submit a proposed plan of work with this application. It must include details on the following sections:

  1. **Aims of the investigation**
  2. **Objectives of the project**
  3. **Context of the investigation**
  4. **Theoretical basis**
  5. **Methods of investigation**
  6. **Timescale**
  7. **Expected outcome or outcomes**
  8. **References**
  9. **Bibliography**

Plan of work guidelines:

PLEASE INCLUDE A 400 WORD (MAXIMUM) SYNPOSIS OF THE RESEACH PROJECT FOR THE LAY READER

1. FOR THE PLAN OF WORK: A maximum of 2,500 words should be used. A student may use fewer words if they choose to do so, but may not use more.
2. Use Arial font - size 11
3. Footnotes should be used to provide a reference / citation for the reader. A short and brief explanation (if one is required of a particular point) may be included, but should be used only where necessary and not to circumvent the word limit.
4. The references / bibliography required are not included in the word limit of 2,500 words permitted, but should not exceed three pages and should adhere to the Arial font – size 11 stipulation.
5. The time-line for the project is not included in the word-limit.
6. Tables and diagrams are not included in word limits but should be used only to explain and enhance as necessary and not as an attempt to circumvent the limit.

Appendix 31: Module 6 - EdD Research Proposal (Fourth Time of Reviewing Literature)

An investigation of the dominant pedagogical concepts among lecturers influencing the teaching and learning of anatomy for physiotherapy practice in the United Kingdom: a constructivist grounded theory study

Name of Principal Supervisor: **Dr Katy Vigurs**

Name of Secondary Supervisor **Dr Cheryl Bolton**

Name of Student: **Hope Gangata**

Table of contents

1 Abstract

347 words

Aim: The aim of the study is to generate a new pedagogical theory that explains current and ideal dominant concepts that anatomy teachers for physiotherapy use to the promote long term learning of anatomy in students.

Context: Physiotherapy is a necessary healthcare service worldwide that traditionally has used physical methods to treat and rehabilitate many health conditions affecting the musculoskeletal system made of bones, muscles, nerves and joints. The numbers of practising physiotherapists and physiotherapy training schools has grown tremendously and the scope of physiotherapy practice has widened to over 40 areas of specialisations since the professional birth of physiotherapy about 100 years ago in Sweden and England. Anatomy courses for the musculoskeletal system in physiotherapy degree programmes are seen as essential knowledge but difficult to learn. The teaching and learning of anatomy for physiotherapy lacks explicit pedagogical theory to guide it and is relatively neglected in literature, while in practice, it is taught in a non-innovative and teacher-centred way using lectures and observations of cadaveric specimens (well preserved body parts). Appropriate anatomy textbooks for physiotherapy are lacking and how anatomy courses can underprop the 40 areas of physiotherapy specialisations is unclear.

Methods of Investigation:

The study will use an interpretivist approach by using a constructivist version of grounded methodology to generate the theory from the interview discussions with participants. The methods will involve semi-structured, in-depth and one-to-one interviews with 15 participants (anticipated data saturation point), who are UK-based anatomy lecturers with physiotherapy qualifications from among the 37 universities offering pre-registration physiotherapy degrees. The interviews will be audio recorded, transcribed and then coded and analysed into a new pedagogical theory.

Expected outcomes:

The research will clarify how anatomy for physiotherapy is taught and learnt in the UK, a feature lacking in literature, by providing a new theory of the main pedagogical concepts. The new theory will indicate how human resources, physical resources and time could be most effectively aligned during the planning, teaching and assessment of anatomical teaching for physiotherapy. The writing of new anatomical texts and books will be stimulated to support the new pedagogical theory.

2 Main Text

3162 words minus 677 (Table 1-106 words + Table 2-117 words + Timeline-454 words) = 2485 words Target is 2500

2.1 Aims of the investigations

The aim of the study is to determine a new pedagogical theory that explains current and ideal dominant concepts that anatomy teachers for physiotherapy use and would like use to promote long term learning of anatomy in students.

2.2 Objectives of the project

The objectives of the investigations listed below will apply to both current teaching practices and ideal teaching practices of anatomy teachers for physiotherapy in the UK. The objectives are to determine:

3. the main pedagogical concepts of teaching and learning anatomy for physiotherapy
4. the relationships and dynamics between main pedagogical concepts used by anatomy teachers for physiotherapy
5. how the main pedagogical concepts that anatomy teachers for physiotherapy use influence the planning, delivery, assessment and evaluation of teaching and learning anatomy for physiotherapy
6. how the main pedagogical concepts that anatomy teachers for physiotherapy use influence the quality and number of teaching, technical and administrative staff, learning resources, time resources and use of buildings
7. the standards that anatomy teachers for physiotherapy use to judge as to whether their teaching of anatomy will be effective in the professional practice of graduates five years after graduation

2.3 Context of the investigation

The proposed EdD thesis will consolidate my credentials as a registered physiotherapist, anatomist and educator and has a profound bearing on my professional teaching career at the University of Birmingham, where I am an Anatomy Lecturer and was shortlisted for the Outstanding Teacher of the Year Award for 2015 in APPENDIX 20 from page 255. I am the first physiotherapist to pioneer into anatomy in my country of birth, Zimbabwe, as described in my autobiographical book back-cover on APPENDIX 19 from page 254. I have taught anatomy for physiotherapy for over 15 years at four universities, where anatomy courses for physiotherapy taught by scientists and medical doctors were over detailed, factually heavy, lacked innovation, used the same lecture slides for years and had a poor appreciation of the relevancy of the anatomical knowledge for physiotherapy practice. I am using the current EdD thesis to help me understand the current main pedagogical concepts for anatomy for physiotherapy in the UK and how they could be improved. The EdD will improve my practice of teaching anatomy for physiotherapy and prepare me to be an external examiner for anatomy for physiotherapy in the UK.

The previously successfully passed Module 5 (Level 8) in Appendix 29 on page 299 was a critical evaluation of the relevant pedagogical literature and provided the pertinent historical contextual background of the concepts affecting the teaching of anatomy for physiotherapy in the UK, where the research will be carried out. Below is a summary of the Module 5 work.

Physiotherapy is a universal and indispensable healthcare service (APTA, 2003) that traditionally has used physical methods and advice to treat and rehabilitate many health conditions (Dimond, 1999; French & Sim, 2004), but can now be found in emergency hospital settings and may involve prescribing drugs and giving injections (WCPT-Physiotherapy-Definition, 2015; CSP-History, 2015). The relatively young physiotherapy profession formally started about 100 years ago in Sweden and England after the augmentation of the skills of masseurs with therapeutic exercise and electrotherapy (the use of electricity-based appliances to promote healing and health) (Barclay, 1994; Moffat, 2012).

Physiotherapy has experienced profound development and growth, especially in the last three decades, to become one of the largest allied health professions in developed countries (Nicholls & Cheek, 2006). The growth has been in terms of increased numbers of qualified physiotherapists, training schools (Latman & Lanier, 2001; McMeeken, 2008; Reimer et al., 2013) and the new wealth of physiotherapy knowledge (Crosbie et al., 2002; Krause et al., 2006), as evidenced by more than 40 societies representing different areas of specialisation of physiotherapy in the UK (in the old Appendix 1). Despite the changes within physiotherapy and the growth of physiotherapy, anatomical knowledge (especially musculoskeletal anatomical knowledge) is still seen as core knowledge necessary for providing effective physiotherapy service (Mattingly & Barnes, 1994; Latman & Lanier, 2001; McCuskey et al., 2005; McMeeken, 2008; Thomas et al., 2011; Khan et al., 2015), but is difficult to learn (Johnston, 2010; Bergman et al., 2011; Khan et al., 2015).

Unfortunately in literature, the teaching and learning of anatomy for physiotherapy has been generally stagnant and is taught based upon historical precedence (Latman & Lanier, 2001; Reimer et al., 2013; Khan et al., 2015).. Explicit theoretical and pedagogical innovations on teaching anatomy for physiotherapy are hard to find in literature. The basis for teaching anatomical knowledge to underpin the 40 areas of physiotherapy specialisation is lacking (Mattingly & Barnes, 1994) and is not explicit in literature. There are no anatomy books with physiotherapy clinical examples across the many areas of physiotherapy specialisations and physiotherapy students resort to using anatomy textbooks written for medical students (Mattingly & Barnes, 1994), which can clinically confuse physiotherapy students on how they will be using the anatomical knowledge.

2.4 Theoretical basis

The dominant pedagogical theory found in literature for anatomy for physiotherapy in the USA and Europe is traditional anatomical pedagogy (Mattingly & Barnes, 1994; Latman & Lanier, 2001; Abdur-Rahman, 2007; Melguizo et al., 2007; Prados et al., 2007; Reimer et al., 2013). No literature specific to anatomical pedagogy for physiotherapy in the UK was found. The traditional anatomical pedagogy for physiotherapy is characterised by the use of lectures and students observing cadaveric material during the first year or two of their undergraduate physiotherapy degree programmes. Traditional anatomical pedagogy relies heavily on historical pedagogical precedence, with teachers teaching the same way, one year after the other, and suppresses and discourages the reviewing of teaching and learning strategies and diminishes the hope for pedagogical improvements. The traditional anatomical pedagogy is convenient for anatomy teachers and their institutions, but has been criticised for being teacher-centred, encouraging students to be passive learners and focusing more on the teaching rather than on the learning of students (Saalu et al., 2010).

What the content of anatomy courses for physiotherapy should be is being contested. The anatomical content for physiotherapy has traditionally leaned more towards human musculoskeletal anatomy, with the limbs, back and neck gaining eminence (Mattingly & Barnes, 1994; Latman & Lanier, 2001; McCuskey et al., 2005; McMeeken, 2008). The growth of the scope of physiotherapy to more than 40 areas of specialisations (indicated in the old Appendix 1) to areas outside human musculoskeletal anatomy, such as Cardiac (heart related) Physiotherapy, Mental health Physiotherapy, Vestibular (Inner ear disorders affecting balance) Physiotherapists and Veterinary (animal) Physiotherapy, has made the emphasis on human musculoskeletal anatomy inadequate.

New pedagogical strategies have emerged because of the imbalance between the growth of physiotherapy knowledge into the 40 areas of specialisations and the growth in detail and breadth of anatomical knowledge against the ever reducing available teaching time (Mattingly & Barnes, 1994). Factually overloaded curricula for health students are unsustainable and create mental health problems for health students (Levey, 2001; Goebert et al., 2009). Strategies in support of fewer and low density lectures have been encouraged (Russell et al.,

1984) and health regulatory bodies in UK have forced medical schools to produce less congested weekly timetables (Gogalniceanu et al., 2009; Rubin, 2009).

The Health and Care Professions Council (HCPC) has a legal mandate of approving and registering 16 health professional training schools in UK, including physiotherapy schools (HCPC-Regulation, 2015), based on its own set of generic and compulsory pedagogical principles it inspects annually (HCPC-Training-Standards, 2009). The most significant pedagogical theories promoted by the HCPC are student-centred learning and integration of classroom-based teaching and hospital placements by students (HCPC-Training-Standards, 2009), but are at odds with the teacher-centred traditional pedagogy for physiotherapy found in literature that has emphasis on lectures and laboratory based cadaveric observations (Latman & Lanier, 2001; Reimer et al., 2013; Khan et al., 2015). The desire by the HCPC to encourage autonomous, independent and reflective assessment strategies (HCPC-Training-Standards, 2009) is hard to justify in practice when the most common anatomy assessment regime used is Multiple-Choice-Questions (Vahalia et al., 1995; McLachlan et al., 2004; Bergman et al., 2011), even in UK (Raftery, 1996).

The philosophies and theories of the generic training curricula of the HCPC, which are given without academic references, for the 16 health professions have been left for the national professional bodies to clarify (HCPC-Training-Standards, 2009; HCPC-Training-Further-Information, 2015) because the professional bodies are deemed to understand the specific professional requirements better. The designated professional body for physiotherapy is the Chartered Society of Physiotherapy (CSP) (CSP-Learning-Principles-for-Accreditation, 2011). The CSP reinforces and expands the pedagogical principles set by the HCPC, such as active-learning, student-centred learning and reflection, and adds reliability of assessing the learned student work (CSP-Learning-Principles-for-Accreditation, 2011). Reliability is hard to achieve in reflective work such as essays and reflective professional logs (Vleuten et al., 1991). How the popular traditional pedagogy and the theories from the powerful HCPC play out in educational practice is difficult to know, especially when literature for anatomy from British settings are hard to find.

3 Methods of investigation

3.1 Research approach

The research design was initially carefully synthesised in detail in an earlier Level 8 module in Appendix 28 from page 264 and reviewed since then. The module considered the most appropriate ontological (nature of things), epistemological (how we know what we know), methodological (philosophy influencing the methods) and method (the practical ways of conducting the research) approaches. The study is under a constructivist epistemology and influenced a constructivist version of grounded theory methodology that will be used to allow the key concepts to emerge from the interview discussions with the participants because it encourages the generation of theory. The methods will involve semi-structured interviews, where specific topics are used by the author to guide the interview (but not specific words) (Bryman, 2012), that are in-depth and one-to-one. The interviews will be audio recorded, transcribed and then coded and analysed into a new pedagogical theory.

3.2 Participants

I am hoping to interview about 15 experts, who are both registered physiotherapists and have anatomy teaching experience. The anatomy teaching experience has been chosen because an anatomy teacher will need some time to allow the pedagogical concepts to be created and constructed from their teaching reflections. The anatomy teachers will need time to implement their newly created concepts, to test their predictive value, and modify them, if the concepts need modifications, until robust concepts for running anatomy curricula for physiotherapy emerge.

The anatomy teachers will need to be qualified physiotherapists in order for them to evaluate, as graduates, what type of anatomical information is useful for practising clinical physiotherapy. Non-physiotherapy anatomy teachers deviate considerably from physiotherapy anatomy teachers on what anatomical knowledge is suitable for clinical physiotherapy and hence will be excluded from the study (Mattingly & Barnes, 1994). Physiotherapists with no teaching experience of anatomy lack a broad view of anatomy and more importantly lack the pedagogical reflection that comes from teaching anatomy. Physiotherapy students learning anatomy were considered but were not suitable because the students neither have a good grasp of a wide spectrum of anatomy nor physiotherapy, and are a poor source of knowing what pedagogical strategies of anatomy help in the long term after graduation. While there may be other useful knowledge in other people, other than the targeted participants of anatomy teachers, such as Heads of School, Physiotherapy Leads and Physiotherapy Administrators, they are not close enough to the day-to-day pedagogical craft of helping the students to learn anatomy and their knowledge of teaching anatomy will be not be as rich as the knowledge in the minds of anatomy teachers

There will be two separate selections of participants carried out: an initial exploratory sampling and a follow-up purposeful sampling (Patton, 2002). The exploratory sampling is meant to determine how large the available sample pool of anatomy teachers for physiotherapy is and the nature of their teaching profiles. The exploratory sampling will involve creating an initial contact list of anatomy teachers for physiotherapy from an internet-based search, then snowball sampling to find the contact details of further participants and finally asking the anatomy teachers for physiotherapy on the updated contact list to complete a Pre-Interview Questionnaire. The exploratory sample of an anticipated 80 participants will be sent by email a 'Research Information Sheet for Participants' in APPENDIX 9 from page 237, a 'Consent form' in APPENDIX 10 from page 239 and a 'Pre-Interview Questionnaire form' in APPENDIX 11 from page 240 to gather their information about their teaching profiles.

About 40 Pre-Interview Questionnaire forms are anticipated to be completed and returned and inclusion criteria will be applied to the returned forms to obtain an anticipated purposeful sample of 15 participants, who will be interviewed according to the 'Interview Schedule' in APPENDIX 7 from page 235. The inclusion criteria will reflect the maximum variation of significant variables (Patton, 1990), such as the past physiotherapy and teaching experiences and qualifications of the participants, profiles of the students, size, type and ranking of the university. The inclusion criteria will be decided upon during a meeting between the author and his supervisors after examining the teaching profiles on the completed Pre-Interview Questionnaire forms of the exploratory sample. The size and quality of the exploratory sample will influence the aggressiveness of the inclusion criteria of the purposeful sampling to determine the most information-rich participants, and the inclusion criteria will be lenient if the exploratory sample is relatively small. Follow-up discussions via email, telephone or Skype will be done if necessary.

3.3 Instrumentation

The following instrumentations will be used:

Table-1: Instrumentation to be used

Name of Instrumentation	Purpose	Source of Instrument	Location in appendices section
The Interview Schedule	The general order of how the interviews will proceed	Was designed by the author	APPENDIX 7 from page 235
Research Information Sheet for Participants	To inform participants of the research in layman's terms	Was modified from the Template for participant information sheet from the City University London (City-University-London, 2015)	APPENDIX 9 from page 237
Participant Consent Form	To collect signatures of willing participants	Was modified from the Research Ethics: Sample Consent Form RE5 from the University of Bolton (University-of-Bolton, 2015)	APPENDIX 10 from page 239
Pre-Interview Questionnaire Form	To collect the brief teaching profiles in order to select the most information rich participants	Was designed by the author	APPENDIX 11 from page 240

3.4 Ethical considerations

Ethical approval for the research study has been given by the Faculty of Business, Education and Law Research Ethics Committee of Staffordshire University on condition of making minor changes to be approved by my supervisor and a copy of the approval letter is shown in APPENDIX 12 on page 242. Audio recordings of the interviews will be kept and stored according to the university guidelines and requirements. No harm or hurt is expected on the participants. There will be no association of particular comments by a specific individual in the thesis and participant confidentiality will be preserved. Participants will be told that they can stop participation at any stage if they so wish.

3.5 Proposed Timescales

The proposed timescales of the study are indicated on the next page.

Timeline of Stages	**Duration**	**Already Done**	Month	Month	Month	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	Week 6	Week 7	Week 8	Week 9	**Week 10**	**Week 11**	**Week 12**	**Week 13**	**Week 14**
Month			May-15	Jun-15	Jul-15	**Aug-15**					Sep-15				**Oct-15**				
Week starting			01-May-15	01-Jun-15	01-Jul-15	**01-Aug-15**	**08-Aug-15**	**15-Aug-15**	**22-Aug-15**	**29-Aug-15**	05-Sep-15	12-Sep-15	19-Sep-15	26-Sep-15	**03-Oct-15**	**10-Oct-15**	**17-Oct-15**	**24-Oct-15**	**31-Oct-15**
Task																			
Earlier Module - Designing the Research thesis (Epistemology, methodology and methods)																			
Earlier Module - Literature Review of the Research thesis																			
Writing up Module 6 - Research Proposal (Completed RCD1 Form)	3 months																		
Marking of Module 6 - Research Proposal (Completed RCD1 Form)	4 weeks																		
Internet Based search for Participants	3 weeks																		
Ethical Approval	4 weeks																		
Telephoning Departments to confirm internet based contact details	2 weeks																		
Pre-interview Survey (Sending the Research Information Sheet for Participants, Participant Consent Form to sign & complete a Pre-Interview Questionnaire Forms)	3 weeks																		
Analysing the returned the completed Pre-Interview Questionnaire Forms	1 week																		
Determining the inclusion criteria for the Interview stage + Meeting supervisors to decide	1 week																		
Booking Interview appointments with participants	1 week																		
Interviews Stage	4 months																		
Transcribing Interviews Stage	4 months																		
Familarisation with the range of coding techniques for grounded theory	2 weeks																		
Analysing Transcribed Interviews	4 months																		
Research write-up – Literature Review Chapter (Summary of passed Literature Review in Module 5)																			
Research write-up – Methodology Chapter (Summary of the passed Research Design Module)																			
Research write-up – Results Chapter & Discussion Chapter	11 months																		

Timeline of Stages	Week no.	Week 15	Week 16	Week 17	Week 18	**Week 19**	**Week 20**	**Week 21**	**Week 22**	**Month 9**	**Month 10**	**Month 11**	**Month 12**	**Month 13**	**Month 14**	**Month 15**	**Month 16**
	Month	Nov-15				**Dec-15**				Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16
	Week starting	07-Nov-15	14-Nov-15	21-Nov-15	28-Nov-15	**05-Dec-15**	**12-Dec-15**	**19-Dec-15**	**26-Dec-15**	02-Jan-16	01-Feb-15	01-Mar-15	01-Apr-15	01-May-15	01-Jun-15	01-Jul-15	01-Aug-15
Task																	
Earlier Module - Designing the Research thesis (Epistemology, methodology and methods)																	
Earlier Module - Literature Review of the Research thesis																	
Writing up Module 6 - Research Proposal (Completed RCD1 Form)																	
Marking of Module 6 - Research Proposal (Completed RCD1 Form)																	
Internet Based search for Participants																	
Ethical Approval																	
Telephoning Departments to confirm internet based contact details																	
Pre-interview Survey (Sending the Research Information Sheet for Participants, Participant Consent Form to sign & complete a Pre-Interview Questionnaire Forms)																	
Analysing the returned the completed Pre-Interview Questionnaire Forms																	
Determining the inclusion criteria for the Interview stage + Meeting supervisors to decide																	
Booking Interview appointments with participants																	
Interviews Stage																	
Transcribing Interviews Stage																	
Familiarisation with the range of coding techniques for grounded theory																	
Analysing Transcribed Interviews																	
Research write-up – Literature Review Chapter (Summary of passed Literature Review in Module 5)																	
Research write-up – Methodology Chapter (Summary of the passed Research Design Module)																	
Research write-up																	

3.6 Estimated costs

The funding requirements of the study are marginal and about £500 will be required from the author. The estimated expenditure is indicated on the below listed Estimated Cost Table.

Table-2: Estimated Cost

Expenditure	**Estimated Cost**	**Notes**
Travelling costs	£300	A travelling budget to participants within a radius of 150 miles will be budgeted for and participants over 150 miles will have a telephone/Skype interview. Interviews of participants in the same geographical area on the same day will be preferred to save on transport costs. A travelling budget of £300 will be planned.
Telephone costs	£100	A budget of £100 will be planned for telephone costs during the search for participants and for the telephone interviews with participants based over 150 miles away.
Stationary, printing and photocopying of documents and forms	£100	
Total Budget	**£500**	

4 Expected outcomes

The research will shed light on how anatomy for physiotherapy is being taught and could be improved in the UK, a neglected area in literature, by providing a new pedagogical theory of the dominant pedagogical concepts used for teaching and learning anatomy for physiotherapy. The theory will influence anatomy teachers, course leaders, administrators and students on how anatomy for physiotherapy is planned, delivered, assessed and evaluated. The theory will indicate how human resources, buildings, time and learning resources could be most effectively aligned to support the new pedagogical theory. The new pedagogical theory will stimulate the writing of new anatomy curricula books and anatomy textbooks for physiotherapy students that are in-line with the new pedagogical theory.

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Appendix 32: Journal Publication from an earlier taught EdD Module - The repair-workshop theory: supervising anatomical research

ORIGINAL ARTICLE

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THE REPAIR-WORKSHOP THEORY: SUPERVISING ANATOMICAL RESEARCH

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ABSTRACT

Anatomical research remains constrained in Africa and the development of relevant anatomical leadership strategies is crucial to unlocking the anatomical research potential. The importation of leadership strategies from developed countries may not be relevant in Africa because of peculiar social, political, funding, academic and research contexts. Ambiguous leadership, characterised by unclear goals, is poorly understood and is said to be irrational and driven by pure chance. The current paper describes how ambiguous leadership unfolded within the supervision of BSc Intercalated Anatomy research projects at the University of Zimbabwe, which had an incredibly high degree of unclear goals, using grounded theory research methodology. The analysis of the results produced a rational and normative ambiguous leadership theory model called the 'Repair-Workshop-Theory', which had two types of goals: the initially unclear Year-Goals and the always clear Day-to-Day-Goals. The clarity of the Year-Goals progressed from being vague initially to being very clear at the end of the research projects, as the Year-Goals were being 'discovered', while Day-to-Day-Goals were permanently clear and were the basis of day-to-day rational decisions. The normative principle of 'discovering' Year-Goals allows goals to emerge from the interests of the students, staff and contextual constraints and has significant implications for managing unclear research goals in African anatomy departments.

Key words: anatomy, Africa, ambiguous leadership, unclear goals, garbage can theory

INTRODUCTION

Ambiguous leadership

Effective supervision of student projects requires good leadership. Leadership is generally accepted to mean an intentional 'influence' using decision opportunities by a person or teams of people that shapes the activities and relationships in an human organisation (Yukl, 2002). Ambiguous leadership models are theoretical models that see unclear goals, uncertainty and unpredictability as dominant features in explaining educational leadership (Bendor et al, 2001; Bush, 2003).

Listening to and following multiple cues in an educational system that cherishes holistic education introduces a significant amount of ambiguity (Tiernan and Burke, 2002). Lecturing professionalism contributes towards generating multiple cues (Enderud, 1980) because of the significant professional autonomy lecturers have (Bell, 1989). Organisational hierarchies in universities promote multiple goals and favour ambiguous leadership through fluid participation, fragmentation and loose-coupling. Fluid participation characterises the phenomenon that participants in committees do not participate equally, some individuals are too dominant while some are too passive to make any meaningful contribution (Bell, 1989). The strictest sense of loose-c oupling describes how memberships to committees and activities are not rigidly controlled, or at least portions of the organisation, and allows activities to be conducted as they please (Glassman, 1973;

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Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

Weick, 1976). Loose-coupling and fluid participation make it hard to sustain certain chosen goals over the long run because different people move in and out of leadership committees and the degree of leadership contributions from people in the committees cannot be guaranteed (March and Olsen, 1976; Weick, 1976).

Without question, the most famous variant of theoretical ambiguity models is the 'Garbage Can Theory' (GCT) by March and Olsen (Cohen et al, 1972; Cohen and March, 1986; March and Olsen, 1976). The GCT, also referred to as "organised anarchies" by the authors, consist of three facets of ambiguous models; namely fluid participation, unclear decision technology and problematic preferences. The GCT was presented in two parts: a verbal component and a computer simulation model that has become "the most widely cited simulation models in the social sciences" (page 113) (Fioretti and Lomi, 2010). The decision making process of the verbal GCT was regarded as an empty bin with choice opportunities, problems, participants and solutions being thrown in and by chance solutions emerging. The decisions were made irrespective of goals and the decision mechanism was so mysteriously random and happened by pure chance, like the Brownian motion collision of particles (J. Martin, 1981).

Reasons for choosing the University of Zimbabwe

The Medical School of the University of Zimbabwe (UZ), the oldest university in Zimbabwe, was opened in 1963 and is where the author obtained his BSc Intercalated Human Anatomy Honours degree. UZ was initially affiliated to the University of Birmingham, where the author is based. The school used a traditional didactic approach to teaching, based on lectures, as the cornerstone of its teaching up until the 1980s (Mufunda et al, 2007). The school was proud to have produced quality graduates and it was noted that "our doctors and nurses are as good as any others" (page 170), although the country paid heavily for the reputation when the graduates left for greener pastures (Levy, 2003).

Afrocentric leadership has been hinted to resemble ambiguous leadership models (Daniels, 2012). There are five main reasons for choosing the supervision of anatomical research projects at the UZ as a case for examining ambiguous leadership. The first reason for choosing the UZ is because it is a higher educational institution, where academic freedom enshrined in most universities translates to ambiguity of goals (Lutz, 1982). The second reason for choosing the anatomy department of the UZ is because it has been in a challenging context. Ambiguous leadership models are not well suited for stable educational institutions and seem to find relevance in institutions in tumultuous times and in periods of instability (Bush, 2003), i.e. organisations described as in "severe ambiguity" and in "trying circumstances" (page 583) (Padgett, 1980). The anatomy department in Zimbabwe had very weak staffing levels because of a weak financial base, especially during the excessive inflation years between 2004 and 2008 (Mufunda et al., 2007), and the influence of globalisation creamed off some of their the best academics (Levy, 2003). The anatomy department also suffered from the lack of international academic partners, the lack of reviewing of the anatomy curriculum and the lack of high quality research (Levy, 2003; Mufunda et al, 2007).

Thirdly, by examining the decisions made during the supervision of research in the anatomy department, there is an opportunity of examining the decisions made during the inherently ambiguous process of research (J. Martin, 1981). There is a plethora of 'unplanned decisions' in research projects. Research objectives are usually discovered along the way during the reviewing of literature and are not usually planned at the start of the research process. Fourthly, ambiguous models are said to be a poor match in general in explaining how primary and secondary schools function, but have found relevance in universities and colleges because they are much more complex (Cohen and March, 1986). The larger higher institutions have a greater likelihood of having ambiguity within it, such as the UZ with over 11000

Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

students (University-of-Zimbabwe, 2013), as compared to smaller schools (Noble and Pym, 1970). Lastly, the practical ramifications of the ambiguous leadership models, such as the GCT, have been empirically seen in a minority of cases (Masuch and LaPotin, 1989) and the current paper hopes to provide more empirical evidence.

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The aim of the study was to describe concepts underlying the ambiguous leadership decisions involved in supervising students of anatomical research at the University of Zimbabwe using a qualitative study based on grounded theory, and to produce a new ambiguous leadership theory

METHODOLOGY

The research participants were graduates of the BSc Intercalated Human Anatomy Honours degree from the UZ from 2000 onwards and their supervisors. Six graduates of the BSc Intercalated Human Anatomy degree were interviewed; of whom one later became a supervisor. The number of subjects interviewed was reviewed and adjusted during the data collection process and was stopped when there was data saturation, i.e. when no new insightful conceptual or theoretical knowledge emerged. Each interview lasted between half an hour to an hour and the interviews centred on the subjects describing their three most important decisions that were made and how they dealt with ambiguous goals during their research projects. The consent forms were ethically approved through the Ethical Approval procedures of the Department of Education in the Faculty of Humanities and Social Sciences of the University of Bath before the subjects were contacted. A grounded theory methodology was chosen because the scrutiny of data involved allows the experiences and behaviour of many people to be meaningfully understood and "lifts the data to a conceptual level" (page 636) (Suddaby, 2006) or "a slightly higher level of abstraction-higher than the data itself" (page 147) (P. Y. Martin and Turner, 1986), so as to be generalised. Grounded theory ignores pre-existing theories during the conceptualisation of the new theory and grounded theory cannot be used to confirm old theories (Suddaby, 2006). On the other hand, critically engaging with literature on ambiguous leadership is an important part because it helps to form clear research questions and create possible facets of where the new theory can integrate with established theories (Glaser and Strauss, 1967).

The interviews were coded using three rounds of coding: open coding to assign the initial codes and themes, axial coding to refine the newly created codes and themes and selective coding focused on the major themes in the original data and previous codes. The analysis of the codes involved the generation of concepts from the codes and themes. The data collection, coding of the data and analysing of the data was a continual process, with the earlier interviews influencing and shaping the direction of the later interviews and new emerging themes followed up in the later interviews. Care was taken to ensure that the analysis process had gone far enough.

Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

RESULTS

Description of the research supervision

For invariably most of the anatomy research projects at the UZ, the main goal was set on the first meeting between the research supervisor and the student, usually after when the student had fully registered for the degree programme. During the meeting, the scope of the research project "was made broad intentionally" (as one former student described) around a particular structure, with the say of the supervisor carrying more weight than that of the student. All the researches had two goals; to focus on the anatomical research of a particular structure and to determine the clinical or functional implication of the anatomical structure on society. Invariably the students left the meetings "not clear" (as a former student described) of the project and had a hazy idea of the two goals of the research project and felt compelled that they had to do a lot of work in order to refine the goals. The refining of the hazy ideas "took time to understand", as one former student described. The supervisor and student had so much professional autonomy that they could research on practically anything anatomical that was feasible in the local context. A literature search by the students "to build theoretical knowledge" by "reading as broadly as they could" (as described by former students) involved anatomy textbooks, anatomy journals and discussions with other members of the anatomy department. The building of theoretical knowledge helped in refining the hazy idea, over a period of about two months, to a state of having 'an idea with an outline', which was hallmarked by the creation of a 'working research title'.

The completion of a research proposal, a further month or so later, whereby the research aims, research objectives (described as "the most difficult part" by a former student), a provisional methodology and a plausible literature review were delineated and improved the 'idea with an outline' to 'an idea with some provisional substance'. The process of generating a working title or completing a research proposal was an anxious period and the process was like being "thrown into the deep end" (a former student description) and being expected learn how to swim in the research pool. No formal research booklet or research training was given, such as how to search literature, the use of statistics, data collection techniques or research design strategies. The research process that the anatomy students followed was be described as "a form of Problem-Based-Learning" (as a former supervisor described), where the outcomes are very poorly defined and the students have to 'discover' them.

The process of data collection and analysis was not a straightforward one and frequently altered the course of the research project, for example, in some projects decisions were made to make a detour and add a histological twist to the methodology. Day-to-day limitations, time and resource constrains affected the execution of the methodology and forced changes to the methodology. The final thesis was submitted at the conclusion of data collection, analysis, and completing the discussion sections of the thesis. Throughout the research project, decisions were made by the supervisor alone, by the student alone or by both the supervisor and student. The commenting on numerous drafts by the supervisors and discussions during follow-up meetings provided a platform for the sharing of ideas and of making decisions pertaining to the research project. Loose-coupling and fluid participation heavily influenced the major decisions, as evidenced by that "everyone helped in the research project", as one former student described. Interactions within the department with anatomy academic staff, technicians, other academic staff from other departments and especially discussions with the former anatomy students of the UZ, crafted and shaped the decisions made during the research project.

It was only at the point of thesis submission that the two main research goals of the anatomy projects were "fully understood" (student quote) by both the research

Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

supervisor and the student in terms of anatomical research of a particular structure and to have a clinical or functional implication on society. Hence, the initially 'problematic preferences' of the Year-Goals finally became 'unproblematic preferences' at time of submission of the thesis.

Day-to-Day-Problems and Day-to-Day Goals

One fascinating theme that arose to the surface of the interview transcripts was the idea of Day-to-Day-Problems (DD-Probs) and Day-to-Day-Goals (DD-Goals). The educational environment in Zimbabwe, especially between 2006 and 2008, was characterised by university student protests, political uncertainty and hyperinflation. The macroeconomic environment made "bread and butter issues stressful", as one student described. The hyperinflation made goods and services unpredictable in terms of prices, availability, affordability and quality, and affected almost every facet of the anatomy research projects. The high inflation reduced in real terms the value of the local currency and made the four expatriate anatomy lecturers leave by 2008, due to the reduction in real terms of their salaries. The range of anatomy research and the capacity of research supervision dwindled after the departure of the expatriate lecturers, and encouraged a narrower view of the discipline. Research resources became very limited and as a result, decisions made were those that chose "the cheapest research project ideas" and "decisions were based on convenience and available expedient materials and time" (as the former students described). Virtually all the research projects from between 2000 to 2010 were "simple dissection projects" (quote from a former student) on cadavers that usually required simple dissection instruments, priced at around $US10 per set.

The accommodation for students on the UZ campus was closed between the years of 2008 and 2012 because of student unrest and inflationary cost pressures, of which the UZ could not cushion. This made the students travel long distances using unpredictable commuter buses, who were hiking their fares exponentially, as petrol prices were also exponentially rising. Laws were passed to outlaw inflation, but that simply pushed formal businesses into the unregulatable informal sector, and made the acquiring of goods and services depend on whom you could trust and whom you knew. The economic situation "made everything more difficult" and there was a sense that "had things been stable, more of our energies could have been better spent on (anatomy research) projects" (quotes from former students). Thus, the day-to-day living of the students conducting anatomy research was a challenge.

The rapidly changing environment sets the scene for introducing the concept of DD-Goals. Problems arose on a day-to-day basis and will be referred to as DD-Probs, and the decisions made were described as "reactionary to the problems", as a former student described. The DD-Probs were then analysed and prioritised and led to the creation of DD-Goals. "Priorities were changing and we had to follow-up on them", as a former supervisor said. Research decisions on a day-to-day basis hinged on the DD-Goals than on the research Year-Goals, although the Year-Goals were always at the back of the minds of the student and supervisor and these "goals (Year-Goals) were much harder to set and to impose", a quote from a former student. It became very apparent that the key to understanding ambiguous leadership at the anatomy department was by having a good pulse of the DD-Goals. The "more rapid the changes, the more frequent meetings were required with people in the department" (a description by a former student).

There was a strong link between the identification of DD-Probs and the high rate of solving problems and new problems were being created daily. When "bread and butter issues" were solved for the day, higher inflation prices the following day presented new problems. In the current study, there was a high rate of attempting to solve problems which surprisingly did actually solve most of the problems. However, the hyperinflation created an avalanche of new problems as rapidly as the old problems were being solved.

Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

DISCUSSION

Ambiguous theory models could be normative

Ambiguous leadership models have been described only as descriptive theories, unlike most other theories on educational leadership, which are both normative and descriptive (Bush, 2003). The most fascinating theoretical conclusion of the GCT, comes from the reconciliation of the "theatre-of-the-absurd" phenomenon (where decisions usually do not solve problems), and that goals of an organisation only emerges after decisions are made (March and Olsen, 1976). Understandably, Bendor is still confused at what point actually when goals kick in (Bendor et al., 2001).

The solution lies in separating the goals into Year-Goals and Day-to-Day Goals. The Year-Goals in ambiguous leadership of the current study were only fully discovered after when Day-to-Day Decisions are made and not before, as according to the original GCT (March and Olsen, 1976). It so appears that Day-to-Day Decisions made in ambiguous leadership models of the current study initiated the process of making Year-Goals clearer. Thus, the main role of the Day-to-Day decisions in ambiguous leadership is to solve DD-Probs, in order to make the Year-Goals clearer for the organisation to follow. The continual making of the Year-Goals clearer ultimately kills the essence of ambiguous leadership and implies that ambiguity in organisations is meant to be temporary. No wonder ambiguous leadership theories have not been described as normative theories for organisations to emulate (Bush, 2003).

The evidence from the data indicates that ambiguous leadership should be seen as normative within certain aspects of the education complex. Ambiguous leadership is good because it allows the students to slowly 'discover' career strengths or interests of students. Any student involved in undertaking a research project preferably has to choose the area of their interest and the role of the supervisor is to refine that interest. Most students starting university usually do not know what career path they will specialise in future or have too many goals. However, by the time most students graduate, they are usually clear on what career they preferably want to pursue. To dictate to students what path they should take is not advised, and so students are allowed to slowly 'discover' their career goals during their period at university. University offers the rails to nurture and develop these 'unclear career goals'. Another example would be to look at the recent trends of encouraging student-centred learning, of which the learning responds to the educational needs of the students. Educational goals for students cannot be determined before the academic level of the student is determined and learning preferences of the student are factored in (Bush, 2003), only then can the proper teaching and learning goals be 'discovered'. Pre-emptying the goals without the contribution of the student is not wise. Educational leaders ought to be aware of activities that require the participation of students and other staff present in the schools to discover the goals.

The long-term goals are meant to be rails for educational activity and this is an important point to bear in mind. Goals in ambiguous models are said to be so open-ended that it can justify any behaviour (Bell, 1989), but was not so in the current study, the Year-Goals acted as rails. The rails allowed a limited range of activity. If the research project was on a particular nerve, the student was not allowed by the supervisor to then make a certain bone the main focus of the research project. In ambiguous models, the aims or goals only become transparent after activity of people in an organisation (Cohen and March, 1986), and they can only be 'rationally discovered'. Goal

Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

importation, while being praised for bringing clear goals and is quicker to implement, has been criticised because it forces ideas and interests that do not resonate with the students and local context, and is not sustainable in the long term. Education borrowing of educational systems of UK, Canada and New Zealand, by small countries of Barbados and Trinidad and Tobago failed because the resources, "beliefs, attitudes or cultural values" (page 35) were ignored (Lam, 2011).

Rationality and learning from past decisions

Ambiguous leadership has been given illogical names such as 'organised anarchies' and 'the theatre-of-the-absurd' because irrational decisions are said to occur by pure chance in the GCT and are called "unplanned decisions" (Cohen et al., 1972; March and Olsen, 1976). The evidence from the data indicates that ambiguous organisations have been labelled as irrational simply because the way decisions are made had not yet been elucidated. The role played by DD-Goals partially explains the mechanism of how decisions are made and hence help reintroduce rationality back into ambiguous leadership models. Furthermore, 'unplanned decisions' were actually rationally made in the study. In the corporate business world, a meeting is called for with sufficient notice time, in order make decision and hence that decision will be a planned decision.

The current study failed to find irrational decisions. One participant said the "no solution was made by chance" and decisions were made in a greatly shortened time. The process of receiving the problem, analysing the problem and finding the solution was greatly shortened, in part was due the operating hyperinflationary environment. Some company quotations for consumables ended up being valid for only a few hours or until stocks were available. Most of the planning was done mentally rather than on paper and being filed and minuted. Thus the decisions were unplanned in the sense that they were not scheduled a few days or weeks before, but were still rationally made rather than being chance decisions. Perhaps some proponents of ambiguous models could have been fearful of introducing rationality because it might kill the very essence of the ambiguity of goals. In my current study, introducing rationality did not destroy the ambiguity of goals. Introducing rationality provides a purpose why governments should fund educational institutions with ambiguity of goals.

Reintroducing rationality and the experience factor are key ingredients for leadership learning to occur (March and Olsen, 1975). There was evidence of strong leadership learning from the previous years, remembered by the remaining supervisors and by the former students (who were most readily available and were working in the department). Leadership strategies of choosing resource thin research projects and advising on doing research in an inflationary environment were common themes throughout all the research projects interviewed. The anatomy research projects had high completion rates, signifying that it was not by pure chance that the projects were run. The solutions were virtually all intentional and did not just pop in unintentionally. The solutions were rational in the sense that they were decided upon by the student and/or supervisor and that the student and/or supervisor introduced problems (Bendor et al., 2001). The irrational GCT, that made decisions by chance, would suggest that any non-anatomist would have successfully supervised the anatomy projects at the UZ, which is not true. I am sure even a seasoned anatomy supervisor from elsewhere in the world would have been greatly daunted and overwhelmed by supervising anatomy research in a rapidly changing educational environment because they would lack the experience of leading in a rapidly changing environment with unclear goals.

So, can we salvage something from the GCT after replacing the randomness of the garbage can with rationality? For a start, the name Garbage Can Theory will have to be changed to 'Repair-Workshop Theory' (RWT) to denote that problems are identified and appropriate solutions are rationally applied, as one participant noted that "decisions were based on convenience, available materials and time".

Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

Other parameters of the GCT will remain the same such as choice opportunities, fluid participation, unclear technologies, participants, and solutions, while the problems become the DD-Problems and the 'problematic preferences' become the initially unclear Year-Goals. The current study examined the supervision of research projects and the RWT could be applied into various other social areas settings.

Recommendations and Conclusion

In conclusion, social factors can affect anatomical research and the more we explore how decisions made in ambiguous contexts, the more we will begin to understand the basis and rationality of the decisions. The proposed ambiguous leadership 'Repair-Workshop-Theory' explaining the supervision of anatomical research at the University of Zimbabwe is perhaps the first paper supporting the use of rational decisions in resolving unclear goals. The 'Repair-Workshop-Theory' divided the goals into two types and says that in the presence of unclear goals, the always clear Day-to-Day-Goals can help resolve the initially unclear Year-Goals until the Year-Goals become clear by the end of the year.

I propose that the temporary phase of unclear Year-Goals should be seen as an important transient phase and principle in the education of students. The unclear Year-Goals should be the rails guiding learning and should be getting clearer with time and student participation, until when they are clearest at the end of the educational season, which could be a semester, year or three year period.

Leaders in ambiguous African environments ought to pay more earnest attention to the Day-to-Day-Problems that help set the clear Day-to-Day-Goals because the resolution of the Day-to-Day-Goals will help clarify the unclear long term Year-Goals. Frequent communication with students, teachers, administration staff and technical staff is as important as placing automatic information gathering systems for detecting Day-to-Day-Problems that will help set the Day-to-Day-Goals within the running of educational institutions or departments, especially when the Day-to-Day-Problems are changing rapidly.

Whether or not we understand how the UZ ended up in the described position, the described situation is the very foundation for the future of anatomical research in Zimbabwe. It is then imperative for us, as anatomists, to engage, explore and seek to understand the social dynamics involved in making appropriate contextual leadership decisions that are critical for improving anatomical research at the UZ.

Anatomy Journal of Africa. 2016. Vol 5 (1): 631-639

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Appendix 33: Journal Publication from an earlier taught EdD Module - A proposed worldwide classification system for ways of sourcing of anatomical cadavers that is progressive towards the use of donated anatomical cadavers

EDORIUM Journals

Edorium J Anat Embryo 2015;2:20–25.
www.edoriumjournals.com/ej/ae

Gangata 20

EDITORIAL PEER REVIEWED | OPEN ACCESS

A proposed worldwide classification system for ways of sourcing of anatomical cadavers that is progressive towards the use of donated anatomical cadavers

Hope Gangata

INTRODUCTION

Historically, there were five ways of acquiring cadavers to enrich the learning of anatomy: illegal grave digging, unwilled claimed cadavers, 'purchased' cadavers, unclaimed cadavers and donated cadavers (other synonyms are anatomical donation, body donation and body bequest) [1–6]. The first two respective cadaver sources have become redundant because of the immense social conflict they created [1–3]. There is a clear trend in anatomy schools of moving towards the use of donated cadavers [7], being bolstered by ongoing international debates on best guidelines on using donated cadavers [8], because donated cadavers are probably the most preferred ethically, usually has the least amount of social conflict and fill the void left by persistent shortages of unclaimed cadavers [1, 5, 6, 9]. The paper proposes a classification system of how anatomical cadavers are obtained and could help bring clarity to the landscape of sourcing cadavers.

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FACTORS DRIVING THE POPULARITY OF USING DONATED CADAVERS OVER UNCLAIMED CADAVERS

The use of unclaimed bodies has several criticisms that have encouraged the use of donated cadavers. Donated cadavers are generally easier to preserve in a better state than unclaimed cadavers who have to undergo a time consuming process of trying to locate their relatives before embalming [10]. The number of unclaimed cadavers obtained is potentially liable to further reduction from relatives claiming back some cadavers due to late identification. Although unclaimed cadavers tend to be younger and may even include pediatric cases [10], unclaimed cadavers have very low female numbers when compared to donated cadavers and may compromise the learning of female reproductive anatomy and research [7, 11, 12].

The most potent criticisms against the use of unclaimed cadavers are the negative emotions and ethical issues when compared to using donated cadavers because using unclaimed cadavers allows dissection without the consent of the person-now-dead, depends on the ignorance of the relatives [13] and is "exploitation of those on the margins of society" (p. 248) [14]. The worldwide practice of using unclaimed bodies is simply and sadly based on taking bodies of the "friendless dead" (p. 822) who "do not like it and cannot resist" (p. 819), and targeting communities who cannot effectively protest [15]. In Nigeria, unclaimed cadavers tend to come from the much poorer northern regions of the country [16]. The "Prussian Directives" were fully exploited by anatomy departments under the Nazi realm and large numbers of political victims on the wrong side of the Nazi philosophy ended up being used for anatomical teaching [17]. Across the Atlantic Ocean, a number anatomy schools in USA were once so proud of exclusively using Afro-American as unclaimed cadavers during the time of slavery [18]. The very high proportion of adult male unclaimed cadavers [7, 11, 12] maybe due to more familial isolation in adult males than females.

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There appears to be a reciprocal relationship between the number of unclaimed cadavers and donated cadavers and is driven primarily by the number of available unclaimed cadavers. Increased numbers of available unclaimed cadavers make it harder to obtain donated cadavers, while the scarcity of unclaimed cadavers stimulates the supply of donated cadavers. For example, effective state burial financial assistance for the poor dwindled the supply of unclaimed cadavers [13] and stimulated the use of donated cadavers [5] in the USA (triggered by the horrible Great Depression during the 1930s) [18] New Zealand [19] and in Britain [5, 20]. The state incentivized institutions and undertakers to bury unclaimed bodies for a handsome fee from the state and further reduced the available number of unclaimed cadavers [5]. Actually by the 1960s, the medical schools with the most successful number of donated cadavers were located in states with the most efficient state burial welfare for the poorest [5]. Thus countries with less financial resources should be warned of the significant state financial resources required for successful conversion from unclaimed cadavers to donated cadavers

It is insufficient to say that ethical reasons alone led to the rise of donated cadavers in the USA and UK [5], as some would like to suggest [14, 21] and the demise of unclaimed cadavers is a prerequisite requirement to allow for the rise in the use of donated cadavers. Jones and Whitaker [14], stressed "that anatomists should cease using unclaimed bodies" (p. 246), perhaps by legally banning the use of unclaimed cadavers, as was done in the United Kingdom in 2004 [22]. The reality is that a number of countries, such as Romania [23], have no legal permission to use donated bodies and would be caught in 'no-man's land'.

Unfortunately, the use of unclaimed cadavers is still very popular and extensive. Most countries in the world depend on unclaimed cadavers for most of their teaching cadavers [24]. Even the USA and Canada have failed to stop their dependency on unclaimed cadavers and about 20% of their anatomy departments still use unclaimed cadavers [9]. The numbers of cadaveric donations in recent times is said to have over taken the number of unclaimed bodies used in most countries [14], but this may be misleading. Regions with huge populations of over one billion each are heavily dependent upon unclaimed cadavers, such as China, India and Africa, while Russia has a huge population and is also depended on unclaimed cadavers [4, 7, 24].

PROPOSED CLASSIFICATION FOR SOURCING DONATED CADAVERS BY COUNTRIES

Having gone through the extensive literature (indicated in Table 1) of how countries worldwide are currently sourcing cadavers, the editorial paper would like to propose a classification system of nine grades to show the progression of various countries towards using donated cadavers and the amount of success they have had. The proposed classification of sourcing of cadavers by countries could help anatomy teachers by indicating countries similar to them and countries on the next progressive stage they could learn from.

Grade-0 is a hypothetical grade and it represents countries without medical schools and which might have failed to obtain cadavers because of a number of factors. Grade-0 countries would typically be countries of limited financial means or legal means to allow for the importation of cadavers.

Grade-1 represents countries (e.g. Muslim dominated countries in Northern Africa and the Middle East and some Caribbean countries) that have failed to obtain cadavers from within its own borders and is an indication of the tenacious resistance against all forms of local sourcing of either unclaimed cadavers or donated cadavers. Grade-1 represents countries that have opted for the importation of cadavers and have supportive legislation. Grade-1 countries are relatively wealthy countries, like Middle East countries, or countries with medical schools with relatively high tuition fees in less wealthy countries, like the various medical schools in Caribbean countries whose graduates are trained for the USA market. Although the cadavers are not 'bought', some excessive transportation and shipping costs (probably about $8000 per body) by some entrepreneur companies in USA ought to be probed by the exporting/importing governments and the International Federation of Associations of Anatomists, to avoid tarnishing the good will of anatomical donors. Anatomical education could be jeopardized if the government authorities are heavy handed. The disposal of the 'bought' cadavers could be a source of ethical irritation when it becomes difficult to resend the remains of imported cadavers due to the state of the remains confusing the border control officials or costly return transportation.

Grade-2 countries represent countries (e.g. Romania; Turkey and most sub-Saharan African countries such as Cote d'Ivoire, Ethiopia, Kenya, Nigeria, Zambia) using ancient legislation solely depend on unclaimed cadavers. A mix of ignorance on body donations by the public, the relative ease of obtaining unclaimed cadavers, the reluctance by anatomists to face the anticipated cultural resistance and state legislations that does not allow body donations are the major impediments among Grade-2 countries. Some have found that the setting up of body donation administrative structures too difficult, although administrative resources for body donation programs can be pooled together and a centralized anatomy body donation centre can be set up [16], such as London Anatomy Office which runs for seven medical schools in London [25].

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Table 1: Proposed classification of sourcing of cadavers around the world

Classification Grade	Description	Countries	References
0	Countries that have failed to acquire any cadavers	Countries without medical schools	Personal hypothesis
1	Unable to use unclaimed cadavers and donated cadavers. Use purchased cadavers as a last resort	Caribbean countries	From personal email correspondence
		Muslim dominated countries in Northern Africa and the Middle East	[7]
2	Content to exclusively use unclaimed cadavers	Most sub-Saharan African countries (e.g. Cote d'Ivoire, Ethiopia, Kenya, Nigeria, Zambia, Tanzania)	[7, 10, 12, 16, 30, 31]
		Romania	[23]
		Turkey	[32]
3	Virtually all cadavers are unclaimed cadavers but unpromising campaigns towards donated cadavers have been made or planned	Serbia	[24]
		Singapore	[33]
4	Virtually all cadavers are unclaimed cadavers but promising campaigns towards donated cadavers have been made	Brazil	[34, 35]
		China	[36]
		Italy	[23]
5	Largely use unclaimed cadavers and some donated cadavers	Ghana, Malawi, South Africa, Zimbabwe	[7]
		Bangladesh	[37]
		Hong Kong	[38]
		India	[4, 39–41]
		Russia	[24]
		Chile	[42]
6	Largely use donated cadavers and some unclaimed cadavers	Germany, Portugal, Spain	[23]
		USA	[9]
		Thailand	[43, 44]
7	Exclusive use of donated cadavers with limited success	Australia	
		Austria, France, UK	[23]
		Israel	[45]
		Japan	[46]
		New Zealand	[47, 48]
8	Exclusive use of donated cadavers and with excellent success	Netherlands	[23, 28]
		South Korea	[27]

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Grade-3 countries (e.g. Serbia, Singapore) solely depend on unclaimed cadavers and have made unsuccessful bold attempts to start or have planned body donation programs. The lack of proven public support for body donations characterizes these countries.

Grade-4 countries (e.g. Brazil, China and Italy) are even more promising than Grade-3 countries and have had recent limited promising results for their body donation initiatives, especially in their large mega-cities e.g. China and Brazil. Grade-4 countries face far less resistance than the above three grades, have the body donation legislation on their side and need to broaden their body donation programs for a wider audience.

Grade-5 countries (e.g. Ghana, Malawi, South Africa, Zimbabwe, Bangladesh, Hong Kong and India) are similar to Grade-4 countries, but have been having body donations on a small scale for many years and donated bodies account for a small percentage of annual cadavers. Some body donations are probably on an 'autopilot' and medical schools receive body donations without anybody donation outreach programs because the public have limited awareness of donating.

Grade-6 countries (e.g. Germany, Portugal, Spain and USA) have turned the tide from largely using unclaimed cadavers to largely using donated cadavers and are a result of active body donation programs. Unclaimed cadavers make up a smaller percentage of cadavers for Grade-6 countries.

Grade-7 countries (e.g. Australia, Austria, France, UK, Israel, Japan and New Zealand) exclusively rely on donated cadavers for mainly legal reasons but all have limited success in obtaining enough numbers of cadavers, in contrast to Grade-8 countries who are able to obtain all the cadavers from body donations.

Grade-8 countries (e.g. The Netherlands and South Korea) are characterized by aggressive, active and successful body donation programs and do not use any unclaimed cadavers. South Korea is perhaps the country with most organized and well-run body donation program that is fully known by most stakeholders. South Korea has a government run Korean Network for Organ Sharing [26], which has over 2000 centers nationwide to coordinate organ and body donations and has glossy adverts containing celebrities and use almost every conceivable media [27]. There is hope. It must be borne in mind that a tiny percentage of donors are required to sustain a body donation program. In Netherlands, a mere 0.1% of the population of 16.5 million enlisting to be body donors was enough to provide adequate numbers of cadavers of 650 per year [28]. Organ donation needs higher numbers and 28% of the population was not enough [29].

The proposed classification system provides a bigger perspective of practices and policies of sourcing cadavers around the world, helps individual countries to know where they are relative to other countries and what stages they are yet to progress onto. The classification system provides a succinct way of describing the sources of cadavers. For example, a methodology of a certain paper can now report saying "cadavers used in the study were obtained using Grade-5 of the Classification system of sourcing cadavers". The classification system could help drive up ethical standards if ethical research committees and research funders require research, for instance, to have a Grade-4 or higher on the classification system before approval.

The proposed classification was based on available literature and could have been more robust had the author been able to visit all the mentioned and unmentioned countries. The paper has taken a national reflection which might not obscure significant variations of medical schools within a country, especially in large and diverse countries such as India, China, Russia and USA. Nevertheless, the classification system can still be applied at regional, city or university levels. The review was mainly focused on English speaking countries that had literature on cadavers, due to the linguistic limitations of the author.

In conclusion, the proposed classification system provides a concise way of comparing sourcing of cadavers and could assist ethical committees and research funders in setting ethical benchmarks for sourcing cadavers.

Keywords: Donated, Unclaimed, Teaching, Cadaver sources

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Hope Gangata – Substantial contributions to conception and design, Acquisition of data, Analysis and interpretation of data, Drafting the article, Revising

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Authors declare no conflict of interest.

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Appendix 34: The Recommendation Report by the Examining Team for my Oral EdD Thesis defence

RDC14
(EdD)

RECOMMENDATION

The Examiners are requested to select ONE of the recommendations listed below and where revisions are required these are to be specified on page 3:

(Please circle the recommendation that applies)

i. that the Professional Research Module has been successfully completed; or

ii. that Professional Research Module will be successfully completed, subject to the student making corrections to his or her thesis/portfolio to the satisfaction of the examiners; or

iii. If the thesis/portfolio was satisfactory but the student failed to satisfy the examiners during the viva, the student shall be permitted to re-present the thesis/portfolio and take part in a re-examination within a period not exceeding twelve months from the date of the first examination, OR;

iv. If the thesis/portfolio, though unsatisfactory, has sufficient merit, the student can be permitted to re-present his or her thesis/portfolio in a revised form and undergo a second examination. The re-examination to take place within twelve months of the first examination; or;

v. That the Professional Research Module was not satisfactorily completed nor defended and the student should not be allowed to revise and resubmit his or her thesis/portfolio for a second examination.

Please sign the form below: [redacted]

External examiner: [redacted]

Internal examiner: [redacted]

Chair: [redacted]

Staffordshire UNIVERSITY

RDC14
(EdD)

RESEARCH DEGREES SUB COMMITTEE

FINAL RECOMMENDATION OF THE EXAMINERS ON A CANDIDATE FOR THE DEGREE OF DOCTOR of EDUCATION

(This form should be typewritten)

The Examiners are required where possible to complete a joint report on this form on the oral or alternative examination, the result of the examination as a whole and to make a recommendation to the University on the award of the degree.

Note: If an agreed report cannot be submitted, each Examiner should report separately.

Name of candidate:	**Hope Gangata**
Final Title of Thesis:	**An analysis of the pedagogical concepts used by anatomy teachers to facilitate the teaching and learning of anatomy to physiotherapy undergraduates in the United Kingdom: a constructivist grounded theory study**
Collaborating Establishment (if any):	
Date of submission of thesis:	**January 2017**

Date of examination:	20th April 2017
Location of examination:	Room B169, Brindley Building, Stoke-on-Trent
External examiner:	Dr Sandra Naylor
Internal examiner:	Dr Lynn Machin
Chair of examination (RDSC member):	Professor David Williamson
Supervisor (if present):	Dr Katy Vigurs

REPORT OF THE EXAMINERS ON THE ORAL EXAMINATION

The Examiners are requested to report below on the oral examination of the candidate giving an assessment of the candidate's performance.

a. Are you satisfied that the thesis presented is the candidate's own work? ......Yes..........

b. Did the candidate show a satisfactory knowledge and understanding of:

(i) matters relating directly to the thesis? ......Yes...........

(ii) background studies relevant to the subject of the thesis? ....Yes.........

c. In the case of a candidate whose research programme was part of a collaborative group project, did the oral examination demonstrate that the candidate's own contribution was worthy of the award? ....

Continued overleaf.....

RDC14
(EdD)

JOINT EXAMINATION REPORT

The examiners are asked to write a short joint report on the candidate's oral examination and to comment on the examination as a whole.

The examination proceeded as scheduled and was conducted in a professional and friendly manner. Following introductions the candidate made a five minute PowerPoint presentation, outlining the justification for the thesis, the approach followed, and the recommendations made. The examination then commenced, with the examiners asking questions agreed in the pre-meeting. In total the examination lasted just over two hours and the opportunity for a comfort break was offered. A rigorous and comprehensive question and answer session was witnessed by the Chair. The candidate and the supervisor then left the room to allow the examiners to deliberate on their decision and recommendations.

The issue of the time period allowed for minor and major amendments was raised by the external examiner, which the Chair then checked with the research administrator as the EdD documentation did not specify these details. It was agreed that we would apply the PhD rule of 6 months for minor amendments and 12 months for major amendments, and that this would be clarified as being correct by the University at the earliest opportunity. The candidate was informed of this development.